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The Technical Director

We doubt if prior to 1914 the term "technical director" had entered into the English language, but from then onwards the tendency for large firms to create such positions has been constantly increasing. The somewhat smaller firms, however, still interpose the managing director between the Board and the technical executives. This system has but little to commend it, as the managing director cannot very well avoid his views on technical matters being warped by financial considerations. The usual result of such an arrangement is that the Board places the whole of the responsibility for decisions on technical matters upon the managing director. By appointing a technical director, the opportunity is afforded the managing director of correlating all technical propositions with financial considerations. Conversely, constant contact by the principal technical executive with the Board gives added opportunities for conducting the technical business of the concern in proper alignment with the Board's financial policy. Moreover, such personal contacts tend to prevent the exploitation of processes brought directly to the notice of a director by some casually introduced and often unknown outsider. An informal meeting between the technical director and the "outsider," followed by an equally informal report to the Board, would in many cases get the proposition into a much better perspective in quicker time than is usually the case. At the moment a particularly attractive metallurgical process is being hawked round the City of London. It is presented in such a way that it would appeal to many enterprising financiers, but any technical director worthy of the position would spot the inherent metallurgical weaknesses it contains. If the technical director can and does afford protection, as well as materially contributing to the financial success of the larger establishments, surely emulation is worth while by the medium-sized concerns? Whilst it may not be politic to create an actual directorship, the principal technical executive should be treated more as partner and less as a departmental official—a suitable appellation for this official is not difficult to find.

A.R.P. Workers and Injuries

A retrospective view of all the emergency measures taken as a result of the war suggests many things that have been well done, some things which stand in need of revision, and a few things that still require urgent attention. Certain arrangements had to be completed hurriedly, such as those in connection with air-raid precautions, and in this connection experience is gradually pointing to the need for revisions while omissions calling for early attention are disclosing themselves. One matter of major importance concerns the legal position of owners of foundries, works and factories in regard to compensation for A.R.P. workers in the event of injury, fatal or otherwise, sustained in the course of their duties.

All employers of more than 30 persons in vulnerable areas are under statutory obligation to provide protection, and to see that a certain proportion of their employees are trained in air-raid precautions. A moral obligation rests upon all other employers to do what is necessary in their particular circumstances to afford suitable protection. This naturally costs money, and towards the expense, owners of works, etc., are allowed a sum equivalent to the standard rate of income tax. Having made this contribution towards the protection of their employees, responsibility for any injuries sustained by those taking advantage of it, clearly rests upon the Government, whether due directly to enemy action or to preparation in anticipation of it. In the scheme drawn up by the Minister of Pensions in September, under the Personal Injuries (Emergency Provisions) Act, 1939, the civil defence organisation so far as it concerns industrial and commercial undertakings is defined as meaning organisation of persons who are being trained or equipped to give first aid, to deal with the effects of gas and to fight fires, or to act as instructors. The scheme, however, appears to exclude large numbers of workers engaged in A.R.P. duties, from compensation for injuries received during rehearsals, training or exercises in connection with air-raid precautions.

The British Employers' Confederation have prepared a memorandum on this important aspect of A.R.P., urging that the definition and the scope of the present scheme as it applies to industrial and commercial undertakings calls for immediate and urgent review in order to secure that all workers engaged on such work, whether as members of an organisation or as members of staffs being trained or exercised in the routine to be followed, or carrying out such routine, will be entitled to compensation under the scheme, which, it is obvious, lacks definition, is too restricted in scope and calls for early revision in the interests of all concerned.

C

Cast Iron for Machine Construction

SOME OUTSTANDING PROPERTIES

MR. A. LE THOMAS, the popular director of the French cast iron research institute, has recently put forward some interesting views on the subject of meeting the modern requirements of the engineers so far as iron castings are concerned. Mr. Le Thomas first summarises the properties and principal qualities of grey irons:—

(1) The ease of casting which allows the production at a reasonable price of castings presenting wide varieties of shape. This quality is the result of several factors amongst which one must cite the cupola (a particularly simple and economic melting unit), the free running power of grey iron, and the swelling in the mould simultaneously with the liberation of the graphite, and the solidification of the phosphide constituent.

(2) The modest selling price of iron castings, in comparison with other metallic constructional materials.

(3) The regular production of perfectly sound iron castings, free from porosity, draws and other physical defects. This quality consequent upon manufacturing control is of major importance to the machine shop as well as creating confidence in the finished article—factors well worth stressing.

(4) The characteristic of giving excellent wearing surfaces and thereby resisting friction and seizing.

(5) The possibility of widely modifying the physical properties of the iron by altering the chemical composition or the rate of cooling in the mould. One of the most significant examples of the wide variety of the properties exhibited by cast iron, due to manufacturing conditions, is provided by the value of the modulus of elasticity, which can range between 6,000 (highly graphitic irons) and 16,000 (high-duty irons).

(6) The damping capacity, which is much higher than that of steel.

(7) The relatively good resistance to repeated stresses with feeble sensitiveness to notch effect.

(8) The high resistance of grey irons to corrosion and to the action of elevated temperatures, at least with certain reserves.

From the viewpoint of mechanical strength, Mr. Le Thomas recalls that in 1913 a protest was made by an employers' federation to the French Admiralty that it was not possible to give 11.5 tons per sq. in. Nowadays, some Government departments specify 16.5 and even 19.0 tons, with the express proviso that the test-pieces are trepanned from the body of the castings instead of being separately cast as previously. Actually 20.3 to 21.5 tons are regularly obtained in numerous foundries (shear test). Certain high-duty irons give 25.4 to 29 tons, and even 47 tons after heat-treatment, but these last figures do not relate to regular production, because of difficulties in casting very high duty irons.

From the point of view of the homogeneity of structure of castings, reference to the inherent properties of cast iron is desirable. The old method of burdening blast furnaces using charcoal and cold blast—a practice which has practically disappeared by reason of economy—gave remarkably homogeneous and relatively strong irons. Excellent results are nowadays obtainable by the highly-developed refining made possible by the electric furnace. Large quantities of rejected castings can be traced to the operation of too low a cost price, driving jobbing foundries to use cheap and unsuitable raw materials. By following the best information, now readily available to all foundrymen, the well-conducted foundries are regularly mass-producing high-duty castings of complicated design which will pass the most rigid machine-shop and erection inspection without appreciable scrap losses.

Ornamental Castings

Æsthetic principles which have been applied to American cemetery design within recent years have been responsible for a rapid increase in the demand for cast bronze "grave markers." By their uniformity and avoidance of incongruity these markers and the improvements that usually accompany them contribute dignity, simplicity and beauty.

The essential qualifications for these metal markers, says a writer in the "Iron Age," correspond closely to requirements for ornamental bronze statuary, historic or decorative plaques, and architectural castings. They must permit faithful reproduction of fine design detail in unusually thin sections for their area, and legibility for many years despite attack by weather and atmospheric corrosion. To avoid surface imperfections, plaques are usually cast with the design side in the drag or lower part of the mould.

A composition which has a pleasing red colour, and is being used successfully for ornamental castings by many non-ferrous foundries, contains 86 per cent. copper, 2 per cent. tin, 2 per cent. lead, 8 per cent. zinc and 2 per cent. nickel. The relatively high zinc content facilitates production of sound castings by its de-oxidising action. Zinc and nickel, by improving the fluidity of the molten bronze, help to fill all parts of the mould and so reproduce the design in all its detail. Nickel also improves colour and corrosion resistance. The low lead content, although consistent with easy machinability, is reported to promote the development of an attractive oxidised finish after prolonged exposure outdoors.

When a white plaque is required, the nickel-silver casting compositions offer many further advantages. Their resistance to corrosion is somewhat superior to the usual brasses and increases with the nickel content. After prolonged exposure without cleaning, a patina of a soft brown or green colour adheres to the surface and protects it against pitting or further corrosion. A practical composition for the production of metallic white castings contains 60 per cent. copper, 20 per cent. zinc and 20 per cent. nickel. A moderate range of subdued colour tints can be produced by adjustment of the copper, zinc and nickel contents.

Flame-Hardening of Cast Iron

MR. FRED G. SEFING, the author of an extensive article on this subject printed in the "Iron Age," summarises his conclusions in the following terms:—

(1) An average surface hardness of 70 to 75 Shore, of 70 to 75 R_A or 40 to 50 R_{CC} can be attained by flame-hardening cast iron using the proper flame manipulation. From available conversions this is equivalent to 500 to 550 Brinell.

(2) The addition of nickel or nickel and chromium or molybdenum to cast iron improves its response to the flame-hardening treatment so that less heat is required to produce a desired depth of the surface hardness. The lower critical hardening temperature of nickel alloyed irons assists in: (*a*) The production of a deeper hardness by the same heat input; (*b*) less distortion per unit of depth.

(3) The lower stresses resulting from flame-hardening nickel alloyed cast irons compared with plain irons hardened to the same depth cause less distortion.

(4) The distortion stresses due to flame-hardening increase with the depth of the hard layer in the same iron. Therefore, the hard layer should be kept at a minimum thickness for the type of service required.

(5) From 25 to 40 per cent. of the stresses set up by flame-hardening can be relieved by a stress-relief anneal at 150 deg. C. with only a 2 to 5 point drop in the R_A hardness.

Book Reviews

The Beginner's Guide to the Lathe. By Percival Marshall. Published by Percival Marshall & Company, Limited, 60, Kingsway, London, W.C.2. Price 1s. 6d.

This little book very adequately fulfils the object of the author and in its seven well-illustrated chapters it tells the amateur or the apprentice the essential rudiments of lathe operation. It will best be appreciated by those who operate a small workshop as a hobby.

The Mechanic's Repair Shop Manual. By Herbert J. Dyer. Published by Percival Marshall & Company, Limited, 60, Kingsway, London, W.C.2. Price 2s. 6d.

So far as the reviewer knows, this book is unique. No doubt some of the tips included are well known to experienced mechanics, yet there must be many which are novel to even the most skilled. All the jobs cited enter the category of "awkward" and it is probable that a knowledge of the contents of this book will save the maintenance department of even large works, hours of labour. The jobs dealt with include such work as the removal of studs, screws and plugs; extraction of keys; drawing of flywheels and gears; extracting ball-races, bushes, gudgeons and wrist pins; piston troubles and so forth. Whilst fortunately not too many of our readers have to worry with such jobs, they can certainly help their colleagues by acquainting them of the existence of this book.

Publications Received

The Machining of Copper and its Alloys. Published by the Copper Development Association, Thames House, Millbank, London, S.W.1.

There is a forcible reminder in this book that quite often the metallurgist has to make alloys, the principal attribute of which is ease of machining. The foundryman in some shops in America has to regard this as the paramount consideration, whilst the existence of the leaded bronzes is due to this factor. This being the case, it becomes desirable to place the machine-shop manager in possession of the fullest information as to the machining properties of the various categories of copper alloys. This has been splendidly accomplished by this book, and as a result there should be better co-operation between the foundry and the machine shop.

The book, which contains over 100 pages, is divided into seven chapters and four appendices, and takes the subject from the classification of copper alloys, through machining practice, to the selection of suitable alloys for any particular machining job. Prolific use is made of illustrations, which certainly enhance its utility. It is very generous of the Copper Development Association to promise to send a copy of this textbook to any of our readers "giving evidence of responsible status or genuine interest."

Welding and Riveting of Aluminium. Published by the Aluminium Union, Limited, The Adelphi, Strand, London, W.C.2.

It is now a fact that "the welding of aluminium presents no difficulties providing the correct technique and good quality materials are employed," yet it is not many years ago since this operation was regarded as distinctly "chancy." Now, according to this essentially practical treatise, all the major systems of welding are applicable. When using the blowpipe a preference is shown for Propagas instead of acetylene owing to its lower calorific value. There is an especially good section on the welding of castings by this method. The sections on electric welding are distinctly shorter, but no less interesting. The second half of the book deals with riveting, followed by some useful tables.

Cooling Conditions in Ingot Moulds

EFFECT OF WALL THICKNESS ON CAST STRUCTURE

Calling attention to the sparsity of published data relating to the effect of the wall thickness of ingot moulds on the progress of cooling in the poured steel and on the quality of the ingots, I. JA. GRANAT and A. A. BESDENESHNYCH, in the Russian journal " Metallurg," describe investigations of the cooling conditions with a specially constructed circular ingot mould and with standard steelworks moulds for ingot weights up to 7 tons. The factors which determine the soundness or quality of an ingot are various, and include the composition, the temperature and rate of pouring and the heat removal at various levels across the ingot. In the lower parts of the ingot, the dissipation of heat is governed by the bottom plate, at the sides by the thickness of the ingot walls and at the top by convection and radiation to the surrounding atmosphere. The conditions regulating the removal of heat from the ingot during the cooling period to ensure the production of a sound ingot are entirely different during solidification and subsequent cooling, for during solidification the extraction of heat must be greatest at the bottom and gradually diminish towards the top of the ingot. To obtain minimum ingotism, the rate of cooling must be high, while to avoid cracks and other defects the rate of cooling must be retarded during the second stage.

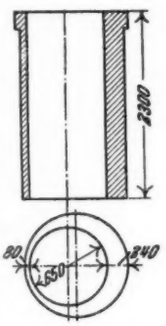
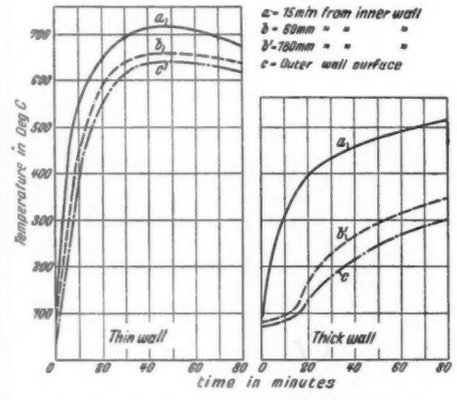


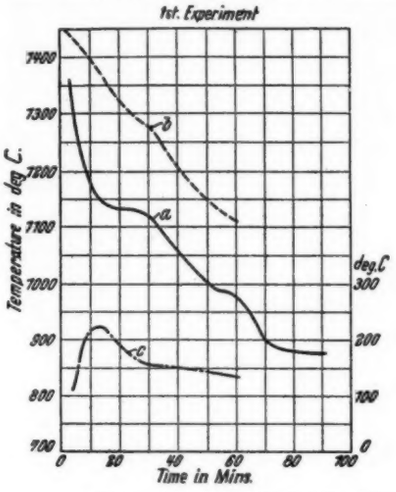
FIG. 1.—CIRCULAR INGOT MOULD, WITH UNEQUAL WALL THICKNESS.

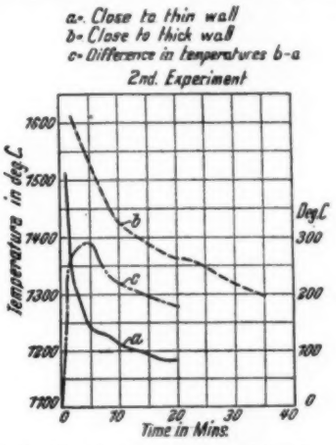
To what extent the wall thickness of the ingot mould affects the cooling of the steel was studied by the authors on a special circular ingot mould with a cross-section as shown in Fig. 1, and also on a number of ordinary steelworks moulds in which standard 7-ton ingots were poured. As shown in Fig. 1, the thickness of the walls of the special mould varied from a maximum of 240 mm. to a minimum of 80 mm.; the same thickness was maintained from the bottom to the top of the mould, so that the ingot had the same diameter at both ends. This design of mould was chosen in order to determine whether a cylindrical ingot, *i.e.*, without the usual taper, would allow the ingot to be stripped. No crop end was provided. The effect of the different thicknesses of mould wall on the quality of the ingot was studied:—(1) By direct measurement of the temperature of the ingot close to the thick and the thin walls; (2) from the results of Baumann prints; and (3) from the quantity of heat removed at the thinner or thicker walls per sq. cm. of ingot surface.



FIGS. 4 AND 5.—TEMPERATURE MEASUREMENTS AT THIN AND THICK WALLS OF INGOT MOULD.

The temperature in the liquid metal was measured with protected platinum/platinum-rhodium thermo-couples, holes being drilled through the walls of the mould on the thin and thick sides halfway up and the couples pushed about 30 mm. into the molten steel. The results of measurements at points 30 mm. away from the walls are plotted in Figs. 2 and 3, where *a* is the temperature curve for close to the thin wall, *b* that close to the thick wall and *c* the curve of the differences ($b - a$). In both experiments carried out the same results were obtained. Comparison of curves *a* and *b* indicates the more rapid cooling of the steel along the thin wall, and that after some time the rate of cooling along this side becomes retarded; throughout the whole period of the experiment cooling on the thicker side was at a slower rate than on the thinner side. The highest rate of cooling at the point of measurement, *i.e.*, 30 mm. in front of the mould wall, was obtained in both cases after the elapse of 8 to 10 min. It appeared, therefore, that the thinner wall extracts and dissipates more heat from the liquid steel than the thicker wall.





FIGS. 2 AND 3.—FIRST AND SECOND MEASUREMENTS OF STEEL TEMPERATURE.

The structure of the ingot cast in this mould of uneven wall thickness was examined by taking Baumann prints. It was observed that shrinking of the ingot had produced a gap between the mould and ingot of 15 to 18 mm. on the thinner side and between only 5 to 7 mm. on the thicker side, another indication that the cooling is more rapid on the thinner-walled side than on the thicker side. After cooling for 2½ hrs. the mould was stripped from the ingot, no difficulty being found in spite of the absence of a taper; not once did the ingot stick in the mould. The authors suggest that ingots of this weight, about 7 tons, do not therefore require a taper to facilitate their stripping, an observation which has an important bearing on possible means for improving the structure of an ingot.

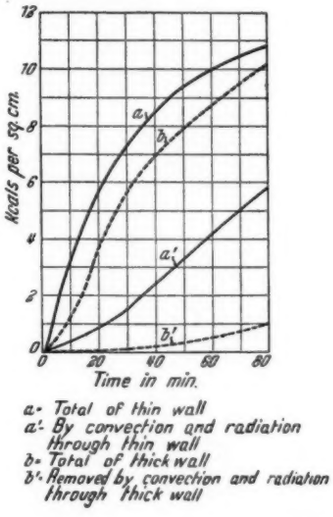

Kcals per sq.cm.
Time in min.
a- Total of thin wall
a'- By convection and radiation through thin wall
b- Total of thick wall
b'- Removed by convection and radiation through thick wall

FIG. 6.—HEAT CONTENT CURVES.

One of the ingots was sawn through lengthwise into two halves, so that one half lay on the side of the thinner wall and the other half on the side of the thicker wall. After polishing the surfaces, Baumann prints were taken, which on inspection revealed entirely different segregation. That half on the side of the thicker wall showed the usual characteristics as found with ingots cooled in ordinary moulds, while the other half appeared more uniform and without the defects of the first half, apart from a segregation streak in the lower half of the ingot. The authors assume that this streak was formed because, as the steel towards the thinner wall had solidified almost to the centre of the ingot, some liquid and naturally very impure metal

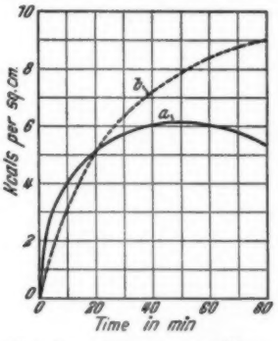


FIG. 7.—VARIATION OF HEAT CONTENT OF THIN AND THICK WALLS OF MOULD.

was still present in this half of the ingot which penetrated between the crystal surfaces of the parts first cooled.

The heat removed per sq. cm. of the surface of the ingot on the two sides of the mould was calculated from measurements with thermo-couples. Apart from measurements made against the mould, readings were also made at points 15 mm. from the inner wall and 20 mm. from the outer wall on the narrower side, and 15 and 60 cm. respectively on the thicker side. The temperature-time curves for one experiment are reproduced in Figs. 4 and 5, similar results being obtained in the other experiments. From these results, temperature zones were derived for the thick and thin walls and the quantity of heat calculated which flowed through 1 sq. cm. of the ingot surface at different wall thicknesses of the mould. In these calculations the heat absorbed by the mould and the loss of heat by radiation and convection were taken into consideration, thus giving the curve shown in Fig. 6, which again shows that a better dissipation of heat is obtained on the thinner side than on the thicker. Although a continuation of the curves over a long period, say 90 to 100 min., would cause the curves to intersect, the superiority of the thinner wall in thermal dissipation is nevertheless maintained until the ingot has completely solidified (about 50 min.).

The heat extracted from the outer surface of the ingot is partly utilised to heat the mould and part is lost by radiation and convection, the relative effects of the thinner and thicker walls in this process being shown in Fig. 7. During the first 20 min. the thinner wall absorbs more heat to raise the temperature of the mould than the thicker wall, calculated on a basis of heat absorption per sq. cm. of ingot surface. After the elapse of this period the temperature of the thinner wall increases only slowly, reaching its maximum value after 50 min. Although cooling of the ingot proceeds, the heat content of the thinner wall now falls, as the predominating thermal process is the transfer of heat to the surrounding air, while the thicker wall continues to register an increase in temperature throughout the whole cooling period. Fig. 6, which shows the heat extracted by radiation and convection, brings out the advantage of the thinner wall over the thicker. The thinner wall removes per sq. cm. of ingot surface about 5 kcals. in 60 min. from the surface of the mould, while the thicker wall causes the removal of only about a fifth of this quantity in the same time. This difference in the thermal conditions on the two sides of the mould has a fundamental bearing on the macro-structure of the ingot and the state of its outer surfaces. The thinner wall absorbs heat from the steel almost from the moment contact is established and removes it by convection and radiation, its own thermal absorption ceasing after about 40 min., after which heat is merely radiated to the surrounding medium, the amount of this radiation diminishing as the temperature on the outer wall of the mould falls. The thermal action of the thinner wall is thus very pronounced at the beginning of the cooling process, and diminishes later, the first stage occurring during solidification, when cooling is very rapid, while the second is coincident with the cooling of the solidified ingot and takes place slowly. These conditions of cooling are, moreover, the optimum desirable for obtaining a sound ingot.

In the case of thick-walled moulds, the heat is dissipated almost solely by conduction, the heat being stored in the mould, although the temperature of the latter does not rise very high in view of the greater mass of the mould. Radiation and convection therefore are only of subsidiary importance during the first stages of cooling, and the intensity of heat transfer decreases only slightly up to the end of the experiment, for which reason the already-solidified ingot cools comparatively rapidly thereafter. These conditions of cooling are responsible for cracks and other defects, particularly in hard steels.

The authors hence suggest that on the basis of direct temperature measurements of the steel in the neighbourhood of the thin and thick mould walls, a study of the ingotism, and the difference in the quantities of heat dissipated by the thin and thick walls, it may be reliably concluded that the thinner wall extracts a far greater amount of heat during the solidification of the liquid steel than the thicker wall.

In the manufacture of heavy tonnages of ingots of a medium-carbon steel an ingot mould is used by the Russian steelworks, as shown in Fig. 8, which has a slight flare towards the bottom. No head is provided for the crop end, but a part of the actual mould used for this purpose. From economic considerations this shape of mould has undoubted advantages, particularly as regards its ease in handling. The thickness of the mould walls, moreover, increases towards the bottom. The steel is poured *via* an intermediate ladle, a 7-ton mould taking 12 min. to teem, and after 1½ to 2 hrs. the ingots are stripped. The principal defects of ingots cast in these moulds are pronounced piping and excessive ingotism.

Examination of the solidified 7-ton ingot with crop end reveals the existence of three zones of dense steel, one where the crop end is joined to the ingot, one at the bottom of the ingot, and the last at the top where a thick metal lid covers the ingot. Piping occurs between the first two zones and piping and segregation of very impure and porous areas between the second and third zones. The second zone is responsible for these areas, since it appears that the latter are formed at a time when the metal both above and below has not yet solidified; these areas therefore separate the crop end filled with molten metal from the lower parts of the ingot, which are also in the molten state. The upper zone is due to the pronounced loss of heat due to radiation and convection, and the third zone to the simultaneous effect of the mould wall and the bottom plate. One of the main reasons for the porosity and low purity is, thus, the bad distribution of heat dissipation, which is at its worst in the second zone. The degree to which these conditions apply may be gathered from an investigation of the temperature distribution and the calculated dissipation of heat at various heights on the ingot.

The temperature was measured at various levels of the 7-ton ingot mould, as shown in Fig. 8, and at three different depths in the mould wall. Measurements were made on a carbon steel, taking 12 min. for teeming. In all, five experiments were made which gave very concordant results, these being shown by the curves in Figs. 9 to 12. The maximum heating of the mould was found at the level of the second zone (Fig. 10).

From these investigations the authors conclude that a thinner wall on an ingot mould carries away more heat during the solidification of the ingot than a thick wall; that the principal cause of ingot defects was, in the cases investigated, the unsuitable design of the ingot moulds, the crop end being particularly disadvantageous; that an improvement can be effected by making the mould wall thicker at the top and by giving the mould no or only a minimum taper, and that the use of a thinner wall mould gives valuable economic advantages, thus confirming the observations previously made by T. Swinden and G. R. Bolsover.

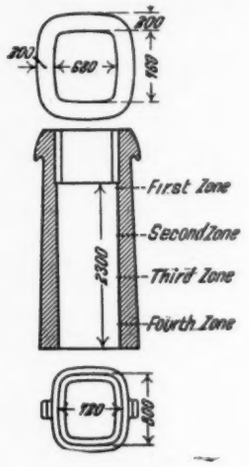


FIG. 8.—7-TON INGOT MOULD.

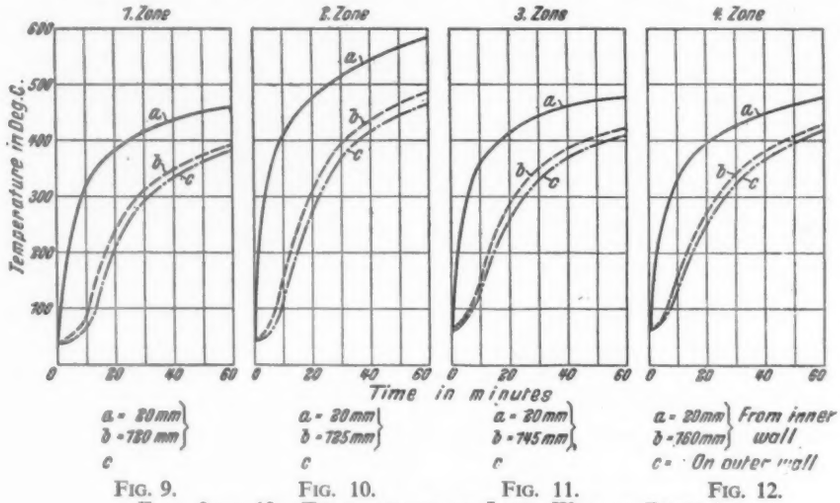


FIG. 9. a = 80 mm, b = 780 mm, c

FIG. 10. a = 80 mm, b = 725 mm, c

FIG. 11. a = 20 mm, b = 745 mm, c

FIG. 12. a = 20 mm, b = 760 mm (From inner wall), c = On outer wall

FIGS. 9 TO 12.—TEMPERATURES OF INGOT WALL IN ZONES 1 TO 4.

Carbonates and Case Hardening

An examination of the equilibria in carburisation during case hardening and the promotive effect of various carbonates, based on a study of the reactions between austenite, carbon monoxide and carbon dioxide and the effects of various alkaline and alkaline-earth carbonates, which has been carried out by O. MADONO, according to his Paper in "Tetsu to Hagane," indicates that calcium carbonate plays no part in carburisation.

East Midland Foundrymen's Opening Meeting

Mr. BUCKLAND'S PRESIDENTIAL ADDRESS

The East Midlands Branch of the Institute of British Foundrymen held the opening meeting of the 1939/1940 session at Loughborough College on October 28. In the absence of Mr. R. Spriggs (immediate Past-President), MR. H. BUNTING (Past-President) welcomed the members. Their Council, he said, sincerely hoped that this opening meeting would be a successful one, and appealed to the members to make every effort to attend meetings.

Presidential Address

MR. R. H. BUCKLAND, the new President, then delivered his address, in the course of which he said:—

MR. BUNTING AND GENTLEMEN,

In the first place I wish to express my appreciation of the honour which you have conferred on me in electing me your President. Thanks to Mr. Spriggs, the past session was excellent in every respect, and with the co-operation of all the members I am sure the new session can be made a successful one, too.

Over two months ago the Branch Council decided on a programme for this session, dates were fixed and several gentlemen were to give technical Papers. The outbreak of war made it necessary to suspend these arrangements temporarily. At a later meeting it was unanimously decided that we should endeavour to carry on during the war—a decision which I am sure will meet with approval. As travelling facilities are often the deciding factor as to whether a member can attend a meeting or not, we have considered it to be in the interests of everyone concerned that the meetings should be held on Saturday afternoons instead of in the evenings.

Apart from the fact that we must meet to transact the business of the Institute, we have the privilege of listening to the discourse of experts in the foundry industry, and of exchanging ideas which can be put into practice to advantage. I do maintain that, by co-operating in this manner, we are carrying out work of national importance.

Lighting Restrictions

Since the outbreak of war, foundrymen have had to prepare themselves for new conditions, due to various restrictions imposed by the Government. Consequent upon the effects of the black-out in the shops, a large number of foundries are having to work entirely by artificial light, whilst most efficient ventilating systems may have had to be reduced to a minimum. It is most regrettable that features which were so highly emphasised in the recently revised Factories Act have to be ignored, and I am sure that the value of better working conditions in foundries and workshops will be realised more than ever.

Value of the Institute

The question is often asked: "What are the objects and what are the ultimate advantages of the Institute?" The answer is, "That we assist to encourage our members to become efficient foundrymen." It is our aim to raise the character and quality of the whole foundry personnel.

The Papers read at Branch meetings all have within them ideas of possible improvements, or suggestions to avoid pitfalls in designs, etc. By a careful study of such Papers, no matter to what particular foundry sphere they refer, one can extract points which are applicable to individual needs, and careful consideration will reveal when and where such methods may be applied to advantage.

The industry owes a great deal to the metallurgists and chemists, and when, as is fortunately often the case, they can lecture in such a way that a moulder can understand, we value them still more. The fact remains, however, that we cannot live by metallurgy alone, and everything should be done to encourage the moulder and patternmaker to relate their troubles. Members will perhaps agree that some of the best meetings have been informal ones, when a moulder has been induced to tell how he made a scrap casting, and why it was no fault of his.

In considering the technical Papers given at meetings, many members get their only insight into the scientific side of foundry work, and thus they become familiar with formula and practice, and obtain at least a rudimentary knowledge of the work that goes on apart from that on the foundry floor.

On the metallurgical side the Institute is responsible for imparting much knowledge to those who are denied the co-operation of a laboratory and its personnel. Results of analysis and physical tests are tabulated in simple form, this being a sphere in which the Institute is an outstanding medium, and in this way the practical man is informed as to the progress in the materials used in the production of his castings.

Importance of Costing

The Institute is often the only means available for many of the practical and technical members to obtain an insight into costing methods. Where an executive has a definite knowledge of how costs are obtained, he forms an extremely good idea of what the ultimate costs in the production of the castings are likely to be.

Through the Institute, the patternmaker may learn of the pitfalls into which he may lead the moulder, particularly when specific jobs are illustrated to show what methods are necessary to overcome moulding difficulties, many of which are created through lack of foundry knowledge. As a result of the patternmaker and foundryman exchanging views on the methods to be adopted, fundamental principles are often originated and made applicable to certain classes of work, so that previous omissions can be provided for in the future.

Co-operation in Design

The foundryman still suffers from the optimism of the designer in regard to the production of complex shapes, and from his pessimism in regard to the strength of cast materials. Undoubtedly progress has been made, but a too rigid dependence on test-pieces is responsible for a somewhat academic attitude which is not always supported by actual practice. However, the designer is beginning to realise that the efficiency of the ultimate product shall be dictated by the expert knowledge of the materials and processes used to produce the casting.

These conditions in the past have been partly due to the reluctance of the foundryman to disclose his ideas to the designer, and partly due to the reluctance of the latter to accept any outside help. Fortunately, this state of affairs is gradually being improved; in many cases the foundry is being consulted before the drawing leaves the drawing board, and invariably the designer will go far to meet the wishes of the foundry.

The Technical Committee

The work of the various Technical Sub-Committees during the past few years has been carried out on a very large scale. The efforts made by the Sub-Committee members are tremendous, and we are all indebted to them for their valuable work, the results of which are being constantly passed on, either as separate pamphlets or in the Proceedings.

It is impossible in so short an address to explain thoroughly the various phases which assess the value of the Institute, but I have endeavoured to elaborate certain main features which, to my mind, clearly indicate that the foundry industry to-day owes its position in the industrial world to the Institute and its members.

Mr. Buckland closed his address by making a personal appeal to the Branch members to do their utmost to attend the meetings whenever possible.

Vote of Thanks

MR. J. F. DRIVER, in proposing a vote of thanks to Mr. Buckland, expressed particular interest in the remarks made about the designer and the foundryman. That question was felt very keenly by some members, and the more the two could meet, the better would be the result.

MR. P. A. RUSSELL seconded the vote of thanks.

MR. BUCKLAND then introduced Mr. A. Sutcliffe, of Bolton. He explained that Mr. Tipper, who was to have given a Paper, was unable to attend as he was that day giving his own Presidential Address to the Birmingham Branch. They were fortunate in having Mr. Sutcliffe with them, who had come at extremely short notice.

MR. SUTCLIFFE then opened an interesting discussion on overcoming difficulties in a general jobbing foundry. He illustrated his remarks by numerous slides and models.

Split Pulley Wheels

In the discussion which followed, MR. A. E. PEACE said he was interested in the split wheels which had been illustrated. He asked Mr. Sutcliffe if they had been cast in half, or in whole, with splitting plates, and how splitting plates were made. He would like to know whether any trouble had been experienced from them. He also asked for information on the method of running in relation to the size of the wheel. That was, taking a small wheel of about 12 in. or 18 in. dia., and a wheel of about 4 ft. or 6 ft.

MR. SUTCLIFFE said they all had trouble with splitting plates. He always wanted a good iron plate core, about $\frac{1}{8}$ in. thick, so that it would not perish. If he could avoid using oil sand he did so. As a rule he daubed a thin coating of oil sand on the plates and sprinkled on some parting sand. This was dried, turned over, and the same thing done on the other side. No trouble was experienced with that, unless it was a heavy one, which would perish. To overcome that, it should be done with ordinary loam. He always ran his wheels in the boss, but nowadays there were newer methods. A great deal of expense, he said, was put on the core. Another way he mentioned was for the wheels to be simply rammed up on a flat plate.

Core Positioning

MR. J. C. HALLAMORE mentioned gas-pipes, and referred to one particular job which was an 8-ft. long steam box, used (he believed) for pasteurising milk. About 18 in. square, it was almost like a pigeon-hole design, made up with cores. There was just room to get a $\frac{1}{4}$-in. barrel through, and no trouble at all was experienced. Did Mr. Sutcliffe make everything in black sand, and had he been talking of

ordinary floor sand, or was it a special mixture of black sand of his own?

Mr. Sutcliffe had mentioned putting four setting strips down the side of a mould for keeping the core central. Did he experience any trouble with knocking little edges off the core, or anything similar? He had also given a case where he stopped "face sprigging" of a mould and later on advocated the use of such practice. Which view was correct?

MR. SUTCLIFFE, in reply, said that the four setting strips were quite easily dealt with. Referring to sand, he said one could pay about 1s. for oil sand and for black sand about 2½d. per cwt. They had to sell the casting, so which one was preferable? If a black sand would answer, then it should be used. He made quite successfully hundreds of lubricating boxes, some of which were not even ¼ in. thick.

Sprigging was just a matter of common sense. The case mentioned by Mr. Hallamore was a rushed job, and the mould had no time to "settle," and "face-sprigging" was a safety precaution. A good job should be allowed time to settle, by being made one day and cast the next. Sand after use should be allowed to rest. If it were allowed to lie over for a day it would make a much better job.

Core Supports

MR. H. BUNTING said he thought they would all agree that Mr. Sutcliffe belonged to the old school of practical foundrymen. There was no doubt that the core irons Mr. Sutcliffe had were a good idea. Anyone with experience of larger cores would realise the difficulty in fastening down the iron without packing, if the chaplet was going to be put straight on to the loam core. With Mr. Sutcliffe's core irons the strength was in the top or the bottom of the core, as the case might be, and it would save a considerable amount of the trouble in making the job secure, so far as lifting strain was concerned.

MR. BUNTING vouched, from his own experience, for the wedge method of supporting a core. He had tried it some years ago, after hearing Mr. Sutcliffe mention it, and had cores weighing 1 ton which had just been rested on the studs.

Another point mentioned by Mr. Sutcliffe was oil being used on the mould. This was a common practice years ago. At a foundry where he had worked some years ago, the moulder used oil on the mould. The method had been proved useless times without number, as it simply added more gas to the mould. They all knew that Mr. Sutcliffe's experience in that class of work was exceptionally good, and whilst he had very direct methods of his own, Mr. Bunting was pleased that they had been fortunate enough to have a man who could give such a practical talk at their opening meeting.

MR. R. F. ORME did not agree with Mr. Sutcliffe when he said he worked off loose pulleys. He knew that Mr. Sutcliffe was original in some of his ideas, but in time he thought he would be forced, through competition, to alter some of his views. Mr. Orme could not understand why black sand was used instead of oil sand. The black sand, he expected, was put through the mill.

MR. R. YEOMAN recalled that he had himself worked many years ago for a firm which employed a similar practice to Mr. Sutcliffe's. One job, a circular tank weighing about 7½ cwts., and about 4 ft. 6 in. dia., made in green sand and with the top skin dried, was made with a man and a boy. He did not think he had seen any similar castings made as cheaply in other foundries. He found himself realising the value of remarks made by Mr. Sutcliffe years ago, and later by Mr. Longden and Mr. Roxburgh, that whatever the foundry practice, it needed the fullest co-operation of the practical man for it to be completely effective.

Founders' Forum

Q.—What is the best type of melting furnace to employ for non-ferrous purposes?

A.—In view of the detrimental effects of hydrogen on casting quality a furnace should be primarily selected which will permit control of furnace atmosphere being obtained. The electric induction furnace of either the low or high frequency type is probably the best unit available so far as this matter is concerned. Unfortunately, the price of such equipment is beyond the reach of some foundrymen, and, furthermore, does not possess sufficient elasticity for general foundry service, although extremely useful for specialised work. For all general purposes, either oil-fired or forced-draught coke-fired furnaces are to be recommended. It should, however, be emphasised that it is advisable to have plenty of air available in order to obtain an oxidising atmosphere if satisfactory results are to be obtained. Particular mention is made of this point in view of the past tendency of manufacturers to base, in the case of oil furnaces, their design on certain fuel oil requirements.

Q.—What could be done if normal supplies of oil were to fail?

A.—Only rarely is equipment installed which will satisfactorily operate on *any* grade of oil obtainable. Such a state of affairs, whilst being of little moment in normal times, when ample supplies of good fuel oil are available, assumes major importance under war conditions. For example, many foundries to-day are using furnaces designed solely for firing with high-grade light oil which could be conserved for diesel engine requirements. Such furnaces utilise low-pressure burners without any means of preheating the oil and are quite unsuitable for firing with the heavier crude or even tar mixtures which might conceivably have to be employed. Accordingly, progressive foundrymen who seek to be prepared to meet all eventualities should give serious consideration to modifications required for satisfactorily utilising heavy oils and which probably will entail some resetting of the burner, supply of higher pressure air, preheating devices to storage tank, oil lines and burner and fitting of drain cocks for use during protracted stops. If necessary, high-pressure air up to 80 lbs. per sq. in. can be utilised direct from the compressed-air supply, often with better results, so far as metal quality is concerned, than when supplied from a fan at the normal pressure of around 1 lb. per sq. in.

Q.—How much air is required?

A.—The amount of air required will, of course, depend upon the size of the furnace. One gallon of fuel oil will need some 2,222 cub. ft. of air for efficient furnace operation, this including an allowance of 30 per cent. excess air over that required for complete combustion to cover the production of oxidising melting conditions and to allow for air leaks. Suggested oil and air feeds for furnaces of various capacities will be as follow:—

Metal capacity of furnace. Lbs.	Oil burner capacity. Galls. per hour.	Air or fan rating. Cub. ft. per min.
150–250	6–8	300
300–500	8–16	600

These requirements are probably higher than those obtainable from burners and fans fitted to the majority of furnaces in service, as it is considered that many are at present underpowered. High oil inputs are economical inasmuch as melting times and fuel consumption per heat are considerably reduced. Furthermore, the higher fuel inputs permit a furnace to be utilised for satisfactory melting of special high-melting point alloys, if necessary.

Q.—Are changes to be made when converting to heavy oils?

A.—For bulk oil storage, steam coils are usually used for preheating oils having a viscosity of over 100 secs. Redwood, whilst thermostatically-controlled electric immersion heaters are most suitable for line use. Preheating temperatures employed are usually fixed at 20 deg. Fah. below the flash-point of the oil. A furnace designed for handling heavy oil can at a moment's notice be changed over to the lighter grades by simply cutting out the oil preheaters and adjusting the air supply.

Q.—What air pressures are needed for forced-draught coke-fired furnaces?

A.—In the case of forced-draught coke furnaces these are also often fitted with insufficient air supply. Air losses on coke-fired furnaces are much higher than with oil firing, but as less air is required for combustion, fans having similar capacities to those given for oil will meet requirements. Air pressures should not be less than 4-in. water gauge.

Q.—How does coke quality affect efficiency?

A.—The quality of the coke has an important bearing on melting efficiency, and the best results are obtained with hard Durham or Welsh brands, similar to that used for cupola operation, but cut or graded to a suitable size for non-ferrous practice. Inferior and softer grades even down to gasworks coke can be employed if necessary, providing the air supply is reduced to counterbalance their quick burning nature. It is also often advantageous to employ smaller crucibles than normal so that more coke can be charged.

Coal-fired, gas and electric arc furnaces unless handled with very great skill and with special precautions, are liable to give gassy metal and degasification should be thoroughly conducted by one or other of the methods given in an earlier question.

Q.—Best-selected copper ingots are widely employed in the production of quality castings. Can alternative grades or copper scrap be safely employed as substitutes?

A.—The solubility of hydrogen in copper has been demonstrated by Dr. N. P. Allen to be dependent on oxygen content. In the presence of 0.05 per cent. oxygen, or more, the hydrogen solubility is at a low level but rapidly increases with oxygen contents below 0.05 per cent. Best-selected copper ingots favoured by the non-ferrous founder contain around 0.05 per cent. oxygen (or even higher in certain cases), and there is no doubt that this materially assists casting production by tending to prevent gas absorption and constitutes a probable reason for the popularity of the grade. There are, however, many other grades available which contain less or even no oxygen at all, and these can be satisfactorily and safely utilised for non-ferrous casting requirements, providing steps are taken to increase the oxide content either by melting under oxidising conditions or by the direct addition of copper oxide. Accordingly, in handling unfamiliar brands the foundryman should first of all obtain some idea of the oxide content. In view of the large number of brands available, full information on this latter matter cannot be given in the space available here, and it is suggested that those who require further advice should communicate with the Copper Development Association, Thames House, Millbank, London, S.W.1; this body will be pleased to give every possible assistance. Broadly speaking, for foundry purposes copper supplies can be divided into three main classes: tough-pitch copper, characterised by containing a small quantity of oxygen present as free red cuprous oxide, oxygen-free copper, and copper scrap.

Effect of Casting Temperature on the Primary Microstructure of Cast Irons

By A. L. NORBURY, D.Sc.

(*Continued from page* 324.)

Part III.—EFFECT OF CASTING TEMPERATURE AND CHILLING ON MICROSTRUCTURE OF γ HYPO-EUTECTIC WHITE CAST IRON

Equi-axed Primary γ Dendrite Structure.—Test blocks similar to those shown in Figs. 1 to 4 were cast in a composition containing 3.5 per cent instead of 4.6 per cent. of carbon (*cf.* Table I), so that the primary constituent consisted of γ, *i.e.*, austenite dendrites instead of carbide plates. The blocks revealed no marked difference in *fracture* due to casting temperature, since the fracture probably followed the eutectic rather than the primary dendrites. Microscopic examination, however, again indicated marked differences.

Figs. 26 to 29 and 30 to 33 show differences in the primary dendrite structure, in the equi-axed region, and are comparable with Figs. 5 to 8 and 9 to 12. The chief feature of these micrographs is that lower casting temperature makes the primary austenite structure increasingly less dendritic, but has little effect on the size of the austenite globules of which the dendrites appear to be composed.

Formation of Primary γ Dendrites.—It is consequently suggested that dendrites are formed by the growth of austenite globules and the subsequent aggregation of the latter into dendrites. This is indicated in Fig. 34 (*b*), and the conventional explanation of dendrite formation, by progressive growth, in Fig 34 (*a*). In the case of a pure metal, the final stages of solidification would be the same in Figs. 34 (*a*) and (*b*) and would consist in the interdendritic liquid depositing solid on the dendrites in the usual manner.

In Fig. 34 (*b*) a line has been drawn in each globule to indicate that each has a single crystalline orientation and that they join up to form a dendrite having a single crystalline orientation. Similarly, the dendrites join up to form a crystal grain in which the dendrites have a single crystalline orientation. Consequently, the effect of lower casting temperature in Figs. 26 to 29 is comparable with a refining of the grain size of the primary austenite.

The explanation in Fig. 34 (*b*) is the same in principle as that in Fig. 25 (*b*), and the effect of low casting temperature in preventing the aggregation of the austenite globules into dendrites and crystal grains (Figs. 26 to 29) is the same as its effect of preventing the aggregation of small carbide plates into large carbide plates (Figs. 5 to 8).

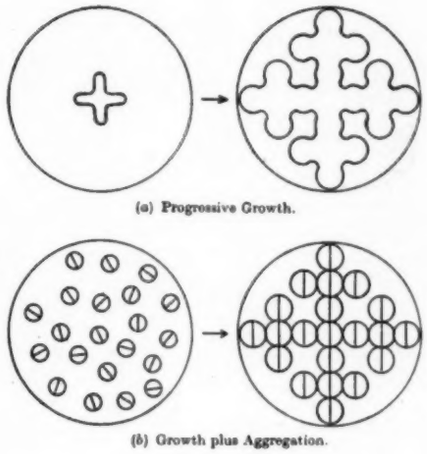


FIG. 34.—THEORIES OF γ-IRON DENDRITE FORMATION.

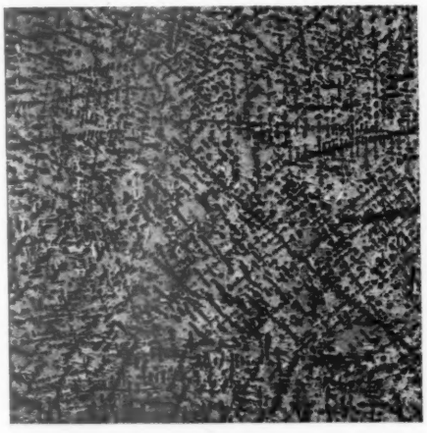


FIG. 26.—CAST HOT. HORIZONTAL SECTION, 2½ IN. FROM CHILL EDGE. × 15.

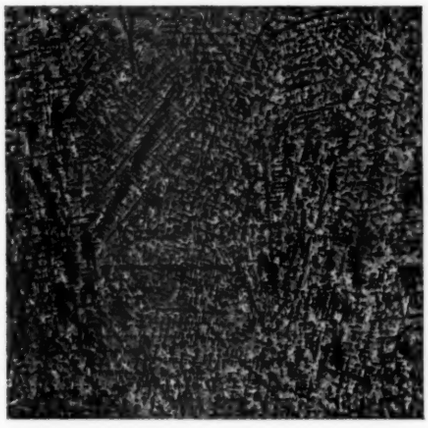


FIG. 27.—CAST MEDIUM HOT. HORIZONTAL SECTION 2 IN. FROM CHILL EDGE. × 15.

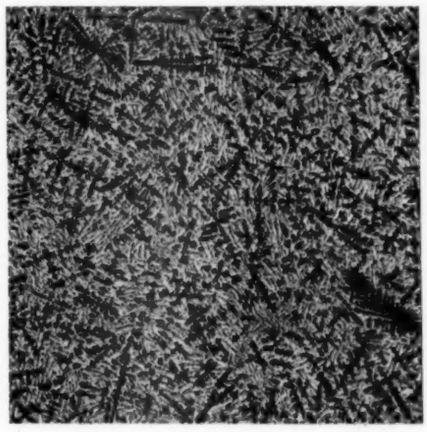


FIG. 28.—CAST COLD. HORIZONTAL SECTION, ¾ IN. FROM CHILL EDGE. × 15.

Columnar Primary γ Dendrite Structure.—The columnar primary γ, *i.e.*, austenite, structure and its reduction in length by lower casting temperature are shown in Figs. 35 to 38, which are comparable with Figs. 13 to 17. On

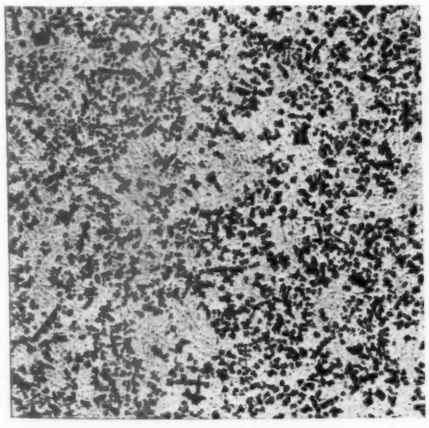


FIG. 29.—CAST PASTY. HORIZONTAL SECTION, ¾ IN. FROM CHILL EDGE. × 15.

FIG. 30.—CAST HOT. HORIZONTAL SECTION, 2½ IN. FROM CHILL EDGE (*cf.* FIG. 26). × 100.

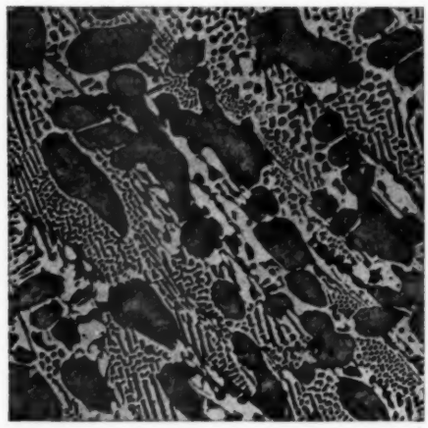


FIG. 31.—CAST MEDIUM HOT. HORIZONTAL SECTION, 2 IN. FROM CHILL EDGE (*cf.* FIG. 27). × 100.

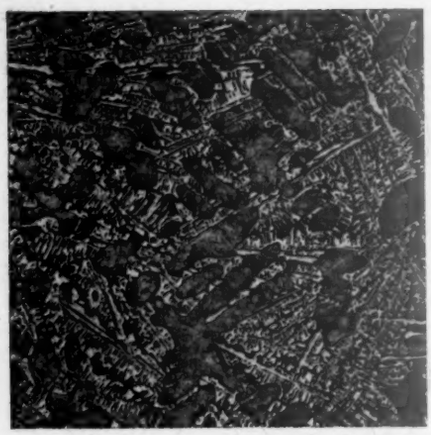


FIG. 32.—CAST COLD. HORIZONTAL SECTION, $\frac{1}{4}$ IN. FROM CHILL EDGE (*cf.* FIG. 28). × 100.

FIG. 33.—CAST PASTY. HORIZONTAL SECTION, $\frac{1}{4}$ IN. FROM CHILL EDGE (*cf.* FIG. 29). × 100.

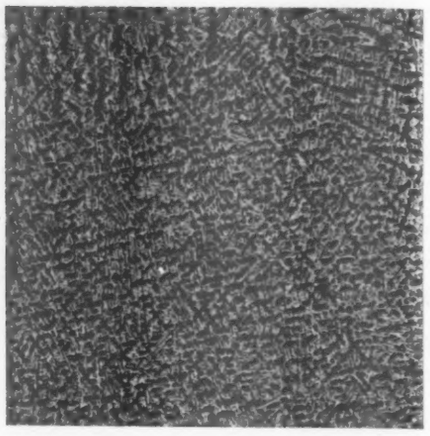


FIG. 39.—CAST HOT. HORIZONTAL SECTION AT CHILL EDGE. × 100.

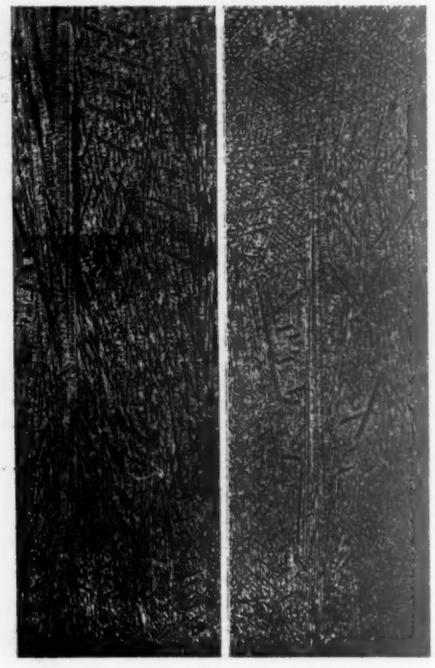


FIG. 35. — CAST HOT. VERTICAL SECTION FROM CHILL EDGE UPWARDS. × 15.

FIG. 36. — CAST MEDIUM HOT. VERTICAL SECTION FROM CHILL EDGE UPWARDS. × 15.

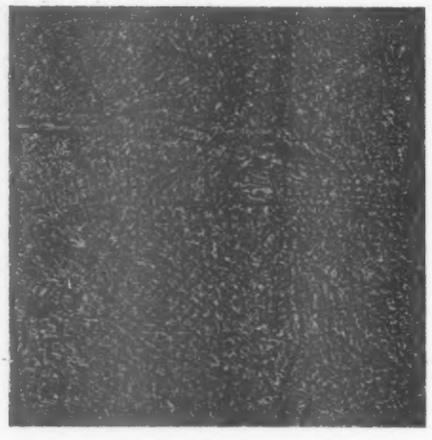


FIG. 40.—CAST MEDIUM HOT. HORIZONTAL SECTION AT CHILL EDGE. × 100.

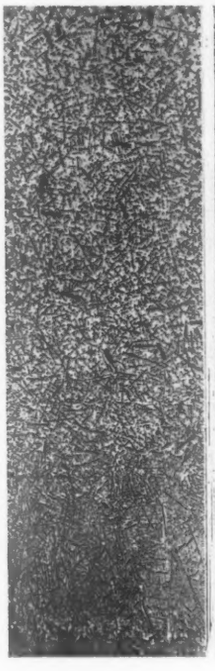


FIG. 37. — CAST COLD. VERTICAL SECTION FROM CHILL EDGE UPWARDS. × 15.

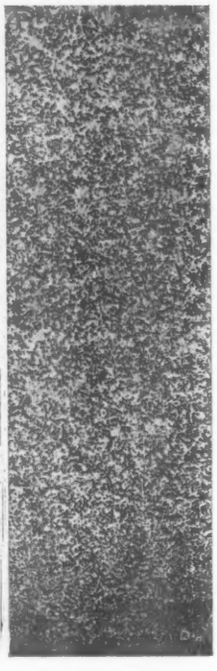


FIG. 38. — CAST PASTY. VERTICAL SECTION FROM CHILL EDGE UPWARDS. × 15.

MICROGRAPHS IN FIGS. 35 TO 38 REDUCED 50 PER CENT. LINEAR IN REPRODUCTION.

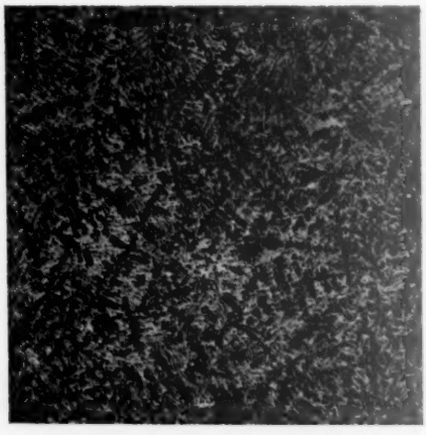


FIG. 41.—CAST COLD. HORIZONTAL SECTION AT CHILL EDGE. × 100.

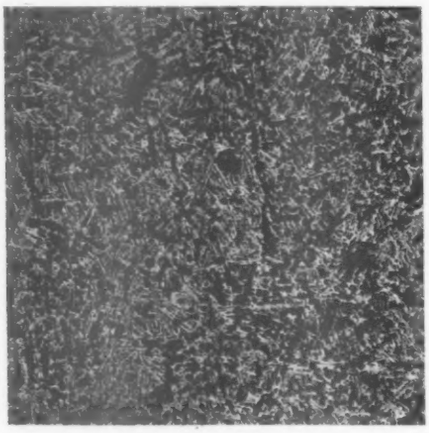


FIG. 42.—CAST PASTY. HORIZONTAL SECTION AT CHILL EDGE. × 100.

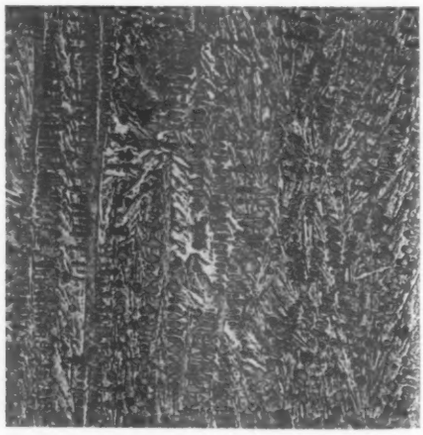


FIG. 43.—CAST HOT. VERTICAL SECTION AT CHILL EDGE (*cf.* FIG. 35). × 100.

the present explanation of dendritic growth, the columnar dendrites in Figs. 35 to 37 are formed by austenite globules forming in the temperature gradient and continuously joining on to and increasing the length rather than the side branches of the most vertical dendrites growing up from the chill edge. The equi-axed primary structures in the upper parts of Figs. 36 to 38 are similar to those shown in Figs. 27 to 29, since these structures were identical in vertical and horizontal sections of the test blocks.

The *horizontal structures* of Figs. 35 to 38 at the chill edge are shown in Figs. 39 to 42 (*N.B.*, at a higher magnification) and again demonstrate the effect of lower casting temperature in preventing the aggregation of the austenite globules. The structures show little effect of columnarisation, since they were those on which the columnar structure formed.

The vertical section of the columnar structure, based on the Fig. 39 horizontal structure, is shown in Fig. 43. Similarly, the vertical section of the equi-axed structure, based on the Fig. 42 horizontal structure, is illustrated in Fig. 44. The horizontal structure comparable with Fig. 39, only farther away from the chill, appears in Fig. 45, which shows the rectilinear cross-sections of the columnar dendrites in this normal section.

Fig. 45 also illustrates the cross-section of the columnarised white-iron eutectic, the vertical section of the same area being shown in Fig. 46. The structure of the eutectic has already been discussed in connection with Figs. 21 and 22, with which figures Figs. 45 and 46 are comparable.

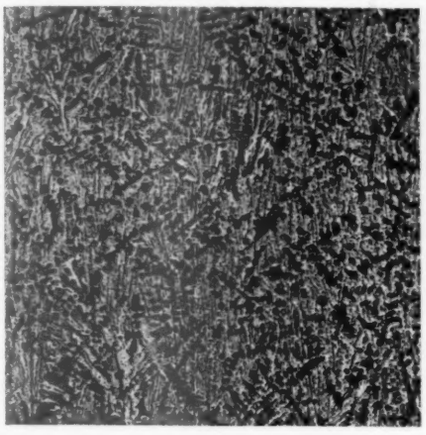


Fig. 44.—Cast Pasty. Vertical Section at Chill Edge (*cf.* Fig. 38). × 100.

Fig. 45.—Cast Hot. Horizontal Section ¼ in. from Chill Edge. × 100.

Fig. 46.—Same as Fig. 42 only Vertical Section (*cf.* Fig. 35). × 100.

It will be noted that the equi-axed and columnar dendritic structures depicted in the above micrographs are, at the lower magnifications, almost identical with those obtained in steels, on the primary microstructure of which differences in casting temperature probably have very similar effects.

(*To be continued.*)

Cupola Melting of Special Irons

By C. D. ABELL

Although cold-blast iron is seldom used alone for castings, but in mixtures containing upwards of 50 per cent. and more of scrap and lower grades of pig-irons, there are several points which are of interest to the practical founder who desires to obtain the best results from his materials, both as regards the economy of melting in the cupola and the elimination of waster castings. In many respects, if not in all, what applies to cold-blast irons applies also to other high-grade irons such as hematite, charcoal irons, etc. The most important features to notice are the temperatures which are obtained in the crucible of the cupola furnace, where the melting and superheating of the metal takes place. The melting of the iron takes place at some distance above the tuyères, the distance being greater at the sides of the furnace than in the centre, so that a section of this melting zone would have a cup-shape, varying, of course, in height according to the diameter of the cupola and the rate of driving based upon the coke to air ratio. The molten metal, which has at this point a temperature of about 1,240 to 1,280 deg. C., is gradually superheated to about 1,440 to 1,480 deg. C., as it falls down over the incandescent coke immediately in front of the tuyères and just above them, but once past this zone it commences to lose its superheat until it reaches a temperature of from 1,320 to 1,380 deg. C., according more or less to the penetration of the blast towards the centre of the furnace by reason of a high blast pressure or small diameter tuyeres. These factors largely contribute to the rate of combustion of the coke in the crucible and thus the degree of superheat obtained.

Consider for one moment the most important constituent of the iron, namely, the carbon, contained both as dissolved carbon or cementite and in the crystalline form as graphite. In the metal charged into the furnace, which will naturally vary in composition according to the specification imposed for the final castings and test pieces, the graphite determines very largely the character of the fracture and the strength of the iron, whilst the cementite, either in more or less intimate association with ferrite as a pearlitic matrix or in the microscopically irresolvable mixture known as sorbite, determines the resistance to wear and the character of the backings of chilled sections.

How Cold-Blast Irons are Made

In making pig-irons in the blast furnace process or by means of the cupola, the most important point to notice is that the mean temperature which obtains in the hearth and which measures the maximum amount of superheat imposed upon the molten iron above its normal melting point, controls the manner in which the primary graphite and ledeburite are formed during the cooling of the iron. For example, an iron which has a normal melting point of about 1,150 deg. C., that is to say, a fairly low total carbon iron, when superheated to different degrees has a different orientation of the primary graphite in each case; and, further, if the degree of superheat in one case is measured by a temperature of 1,420 deg. C. (the critical temperature of the hearth), and in another is measured by a temperature of 1,500 deg. C., the first iron will contain much larger crystals of graphite and more pearlite and in consequence will be tougher and *inherently* "*grey*," whilst the other would show evidences of a chilled edge around the circumference of the pigs, and would be *inherently less* "*grey*" than the former.

The irons have in both cases practically the same percentage analysis but undoubtedly different molecular compositions, that is as regards the amount of the ferrite, cementite, and ferrite-austenite phases. In one respect, namely, tensile strength, the second iron may be superior due to the "curly" nature of the graphite, the former containing "flaky" graphite. One sees then that the inherent nature and properties which may be ascribed to pig-irons are not due to the percentage analysis of the samples obtained but to the conditions under which the iron is formed in either the blast furnace or the cupola. Therefore, in remelting pig-irons, no matter from what source they may have been obtained, one must consider very carefully the most appropriate conditions under which the cupola should be worked. Speaking generally, a quickly-run cupola produces hotter iron but may result in bad mixing, whilst the slowly-run furnace gives a cooler iron but one having a much less heterogeneous character. The duration of the molten iron in the hearth of the cupola is not of such great importance as the actual temperature which it reaches; the higher the temperature the greater the amount of cementite formed and the less the graphite precipitated upon cooling in the moulds.

In the production of cold-blast irons and other high-grade irons such as charcoal iron, and hematite irons, the maximum mean critical temperature of the hearth seldom, if ever, exceeds 1,480 to 1,520 deg. C., preferably nearer the lower temperature, otherwise the iron becomes to all intents and purposes a hot blast iron, where the degree of inherency of the properties is not so greatly dependent upon the conditions existing within the furnace. This

(*Concluded on page* 346.)

The Copperhouse Foundry and Engine Works, 1819-1869*

By T. R. HARRIS

The company controlling the Copperhouse Foundry and Engine Works was originally formed for copper smelting. Cornish foundry work began in 1819 with John Harvey's foundry at Hayle and the Perran foundry of the Fox concern. These were established to cater for the demands of the local mines, for some of the smaller iron castings required in the new engines and iron "pitwork" then being introduced. At the end of the eighteenth century the large cylinders and other important parts of the pumping engines were still imported from Wales or the Midlands.

When Watt's patent expired in 1800 and he had removed from the county, the native engineers endeavoured to improve the pumping engines on the local mines and develop their latent talent that had been suppressed under Watt's monopoly. Among these engineers was Arthur Woolf who had secured a patent for a high-pressure compound engine. This he manufactured in London in partnership with a Mr. Edwards. This partnership was dissolved in 1813 and Woolf returned to Cornwall as engineer to the Wheal Abraham Mine.

In erecting the new engines he met difficulty and delay in obtaining the large castings required from a distance and determined to start a foundry of his own in the county capable of supplying the largest requirements. He was persuaded to abandon this idea and instead was prevailed upon by Harvey & Company to give their small but growing foundry the benefit of his experience as engineer and machinist.

In 1818 a series of letters to the "Out-adventurers" in the mines of Cornwall by a person signing himself "A British Merchant," was published.

In one letter (March 6, 1818) he refers to the Cornish foundries and says, "I intend to let you into part of the secrets of those who furnish them (the mines) with castings. Perhaps it may be necessary to inform you that the number of foundries in the county is just sufficient to enable us to speak of them in the plural and that they understand their business so well and make their calculations with so much exactness that little or no variation is found in their prices. I learn that sometime since a new foundry was in contemplation but as I am informed the person who was to have the management suddenly declined fulfilling his engagement with the proprietors. His inducement has never been *explained* though it has been guessed at. However this may be, the projected competition failed and the 'OLD HANDS' have it all to themselves."

Who was the person declining the management of a contemplated foundry in 1818? Was it Arthur Woolf and was Copperhouse foundry then in contemplation? Actually the Copper Works were converted into an iron foundry probably in the next year although the exact date has not been ascertained. From the available evidence it appears that the Copperhouse foundry was established to break a monopoly held by the Hayle and Perran Foundries for the supply of the small important castings required at short notice and also to supply the Cornish engineers with a portion of the larger and more intricate castings and forgings required by them.

Factors in Cornish Foundry Successes

In the early days of the Cornish foundries different conditions existed in the county from those prevailing in other parts of the kingdom. At this time there was attached to each of the mines a person known as the "engineer" whose duty it was to take charge of the engines on the mine and design and superintend the erection of new ones when they were required. These engineers would have no connection with the manufacturers and on designing a new engine would procure estimates from the manufacturers and subsequently superintend the erection of the work. The Cornish founders unlike the engine manufacturers elsewhere (who designed as well as constructed engines) had an opportunity to concentrate on the manufacture of engines and other machinery.

The design was worked out by an expert and the manufacture executed by a specialist. In this way the Cornish engineers turned out some of the finest engines in the world. The unparalleled success of these engines in the period of 1820 to 1850 caused a great deal of discussion among engineers in London and the provinces, who looked with suspicion on the Cornish engine duty reports, until they were examined by Wickstead and found to be substantiated.

The separation of the office of engineer and manufacturer was of mutual advantage. The manufacturers besides having time to concentrate on the arrangement of their workshops and details of production came into possession of valuable patterns which could be used in the construction of engines for industries outside the county. The practice of engineers procuring portions of their requirements from one place and the remainder elsewhere can be illustrated by a number of examples.

Heavy Castings

Not only did the Copperhouse Company excel in forging, but they also executed some very heavy castings as well. In 1839 a 144 in. dia. blowing cylinder for Dowlais Iron Works was made. Although this cylinder was manufactured in two pieces it was no mean feat for its day, and was probably the largest cylinder that had been constructed up to that time.

In 1846, when two large pumping engines were required for the Haarlem Lake to supplement the one previously made by Harvey & Company in 1843, Copperhouse Foundry constructed a 144-in. cylinder, and the remainder of the heavy work for the engine, which had been contracted for by the Perran Foundry Company. The contract for these engines was made with Harvey & Company and the Perran Foundry Company, but the latter sub-let a part of their contract to Copperhouse. The contract was signed on September 9, 1846, and on January 21, 1847, the cylinder was cast at Copperhouse.

Engines for Waterworks

Another source of business for the Cornish foundries in the middle decades of the century was the supply of pumping machinery to the London and other Water Boards. The introduction of the Cornish system of working into London was the work of Wm. West and N. O. Harvey in conjunction with Thos. Wickstead, and although the Hayle Foundry supplied the majority of the engines, a number were supplied from Copperhouse. An engine of 90-in. cylinder was erected by the company in 1845, and was still working in 1927. This engine was followed by others at Brentford, at Battersea and the Croydon Waterworks. Other engines were also manufactured for the East London Waterworks, notably a pair of filter engines, some of the working drawings of which are still in existence. These are interesting both for the engineering details and for the signatures they carry. Pumping engines were also erected at other pumping stations, as for instance at Leek in Staffordshire.

Marine Engineering

The activities of the Company in marine engineering were considerable. Although they did not build steam boats the Company engined a number built elsewhere and made alterations to existing vessels. For instance, during the last week in September, 1834, the steam boat "Torridge" arrived at Hayle from Bideford (where she had been launched) to receive two engines which were being prepared at the Cornish Copper Company's Foundry. On January 14, 1835, she was ready for sea, and her engines, which were of 45 h.p., were considered by all who had inspected them to be the most complete that any boat in the Bristol Channel had been supplied with. Again, the Company were well situated to effect alterations to engine and boilers of existing vessels, and in 1861 Capt. Bennett, of Falmouth, the owner of s.s. "Duke of Buccleuch" gave instructions to the Company to effect certain alterations in his steamer.

The greatest activity in marine work was the building of three iron schooners, the "Riviere," the "Penair," and the "Margaret." No details of the first have come to hand, but the other two were built in 1861 and 1866 respectively. The "Penair" was 189 tons, 113.8 ft. long, 23 ft. 7 in. broad and 12 ft. deep, and was registered as being built at Hayle in 1861 by Poole.

The "Margaret" was also registered as being built at Hayle by Poole, and was somewhat larger than the "Penair," being 216 tons, 127 ft. 6 in. long, 25 ft. 7 in. wide, and 11 ft. 4 in. deep. Both these vessels were owned by D. W. Bain & Company.

General Work

A list of products made almost at random includes, as ordinary routine work, buddle gear, calciners, stamps, kibbles, shovels, chain, etc. Special reference might be made to a combined engine made some time before 1856 for an iron works near Wrexham, and the 80-in. pumping engine still working at South Crofty, built in 1854, to the order of Samuel Grose, engineer, Gwinear, the quotation for which is in the letter book.

Organisation

The fortunes of the Copperhouse Foundry Company were linked to those of the Cornish Copper Company. An engineer managed most of the internal affairs, although he was subordinate to the managing partner in business matters. One of these managers was Richard Jenkyn, the inventor of the treble cock valve. He was succeeded by John Poole, Jun., the son of the managing partner.

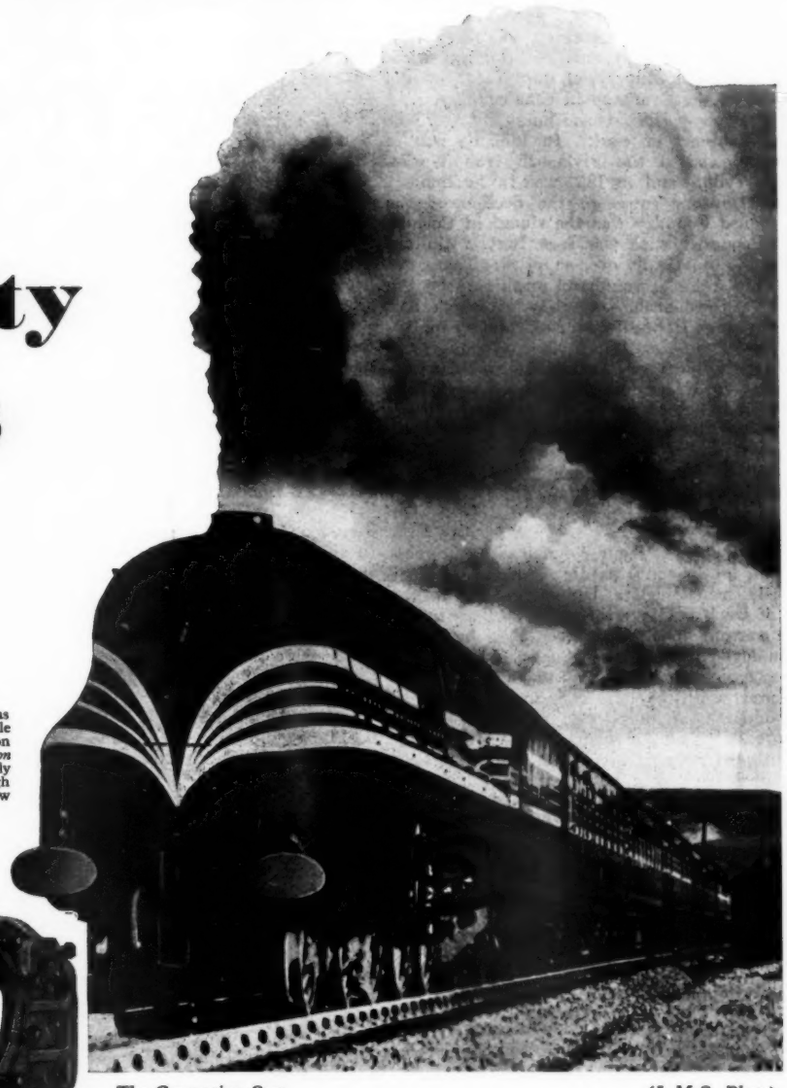
To give the best service to their clients, the Company were in constant touch with a number of local engineers, who were considered experts in their particular branch of engineering. Mr. Grose was an authority on crushing machinery, while Mr. Simms had an extensive experience in compound engines, both of these being consulted on special problems.

To cater for a wider market than the mines of Cornwall regional agencies were set up. For a period Thomas Don, a consulting engineer, served in this capacity in London, and was in communication with the firm on such a variety of subjects as Walker's Patent pump for sewage, Patent slide valve, steam sawing machinery, etc.

Charles Hodge, of Old Broad Street, and a Mr. Tredinnick also appear to have placed work

* Extracted from the 104th Annual Report of the Royal Cornwall Polytechnic Society.

For Quality Castings



The Coronation Scot (*L.M.S. Photo*)

In locomotive castings such as that shown below, Stanton-Dale Refined Iron was used. Dale Iron was chosen for all the ten *Coronation* class engines and can be confidently used in the manufacture of all high duty castings to rigid and narrow specifications.

STANTON-DALE REFINED PIG IRON

Grade	Silicon. %	Sulphur. %	Phosphorus %	Manganese. %	Total Carbon. %
A	1·9-2·1	0·06	0·7	0·8-1·5	2·6-2·8
B	1·4-1·6	0·07	0·7	0·8-1·5	2·6-2·8
C	0·9-1·1	0·08	0·7	0·8-1·5	2·6-2·8
D	2·4-2·6	0·05	0·5	0·8-1·5	2·6-2·8
E	0·9-1·1	0·08	0·25	0·8-1·5	2·7-2·9
F	1·4-1·6	0·07	0·25	0·8-1·5	2·7-2·9
G	1·9-2·1	0·06	0·25	0·8-1·5	2·7-2·9

In addition to the above standard grades, this iron can be supplied to individual specification.

Produced under the most rigid chemical control, Stanton-Dale is a refined iron of dense, close-grained structure, with a total carbon of 2·6 to 2·9 per cent.

The use of "Dale" iron will give a tensile strength of 16-18 tons per square inch, and it is in wide demand for the production of motor car cylinder blocks, locomotive cylinders, hydraulic and pressure work—in fact for all high duty requirements.

Any analysis can be supplied to meet individual requirements.

The Stanton Ironworks Company Limited, Near Nottingham

The largest producers in Great Britain of foundry pig iron for the free market

with the firm. Samuel Hocking was for a time at Fonda-de-Madrid, Seville, Spain, while Francis and John Harvey, of Port Natal, offered to represent the Company in that country.

John Poole, Jun., sometimes toured the country in quest of work. In 1857 he was in Wales and visited the Plymouth Iron Works, Merthyr Tydfil, and in 1859 was in London.

A contributory cause to the decline of the Copperhouse Foundry was the slump in Cornish mining, coupled with the fact that a limited market was practically over-supplied. There was a large amount of secondhand machinery on the market, a considerable quantity of which had been purchased by the Foundry Company for resale.

The geographical position of the works, which was ideal for its original purpose, tended to hamper trade out of the county, especially when more of the firms in the North and the Midlands opened up. This competition was felt early in the 'sixties, and the foundry gradually declined until finally it closed in 1867.

Conditions of Labour

A picture of the labour conditions at Copperhouse can be drawn from Dr. Barham's Report previously mentioned. He states "that the places of work were on the whole well arranged for the convenience and health of the labourers." The employment of powerful cranes for lifting the heavy pieces of cast and wrought iron had "rendered requisite buildings of great height and spaciousness," and it was only in the immediate proximity of the furnaces that "any heat at all intense" was experienced. This was then only experienced by a very few, except at distant intervals.

The regular hours of labour were from 6 a.m. to 6 p.m. in the summer and 7 a.m. to 7 p.m. in the four winter months. The working day was 10½ hours in both cases, 1½ hours being allowed for meals. Of this ½ hour was for breakfast and 1 hour for dinner. Most of the workmen went to their homes for their meals, the others brought their provisions or had them sent, and ate their food in various parts of the works, "chiefly in the smith's shop." No special accommodation for warming the articles of food or eating them in any degree of social comfort was provided.

No systematic night work was engaged in by the workmen, but when "breakages" occurred or the completion of large orders within a limited time was desired, some of them would be called upon to work through the night. Normally two boys were always in attendance at night for the purpose of "feeding the fires" of the boilers, etc.

The length of the working day was often shortened for juveniles by the setting of "a task," which could often be completed 2 or 3 hours before the usual time of closing. On Saturday afternoons the boys were usually set at liberty at 2 or 3 o'clock. The work performed by the boys varied with the shop employing them. Youngsters in the patternshop helped the men and sometimes were trusted with the making of small patterns. The boys would make cores and simple moulds. Their other duties included bringing in fuel in barrows for the furnaces and sometimes feeding them, throwing water on the iron and coke after the furnace had been tapped, and generally helping the men.

In the blacksmith's shop young persons were employed in tending the fires, blowing the bellows, heating the iron and hammering, the tasks being proportioned to their strength. In the fitting shop the more complicated machinery employed some young persons "generally light as to labour, although it demanded attention such as the turning the screw of the larger lathes for the cutting of the cylinders, etc." Later less powerful lathes would be entrusted to these young persons and their skill tested in operations which gradually increased in difficulty until the older lads worked at the other processes of fitting and erecting.

The workmen were described by Dr. Barham "as for the most part rather sallow in complexion and as a class of a spare habit of body." He also suggested that, except that the muscles of the arms and chest were often powerful, their stature was rather under than above the average in this part of England.

The number of employees at Copperhouse in 1841 was 282. This number was composed of 211 over 18 years of age, 56 between 13 and 18 years, and 15 under 13 years. Of the whole number of employees, 37 attended Sunday School, while 63 "read more or less," and 41 had written their own name, their average age being 15 years. The children and young persons were distributed throughout the various departments of the factory in the following order:—In the moulding and iron casting department, ten; in moulding and casting brass, three; carpenters and patternmakers, three; boring mill, two; chipping and cleaning castings, one. Blacksmiths 19, of whom six were in the hammer mill. Masonry (the building of furnaces, etc.) employed three, and boiler building seven. The fitting-up shop, which included "chipping, filing, turning and boring metals," 18; ropemaking, five; and drawing, one.

At these works four boys were entered as maimed, of whom two had lost an eye each "at play," the third had lost three fingers from his right hand in the hammer mill from the hammer falling on them, and the other was lame on one leg from "a hurt" received in Wheal Vor Mine.

Wages

The greater part of the work in the patternmaking and fitting-up shops was done by the piece, and the earnings of the men varied considerably according to the briskness of demand. The average weekly wage* of indoor workmen in 1841 was from 15 shillings to 18 shillings, but occasional earnings of some men when trade was flourishing were said to reach £2 or £3 in the same time.

The boys employed were of two kinds as to hiring and wages, the indoor boys who were learning a trade, and those working out of doors. Of the former many were apprentices, but their pay did not differ from those who were not so, beginning with 3d. or 4d. a day, advancing to about 2s. a day. The outdoor boys commenced with a higher rate of wages, sometimes 8d. or 9d. a day and on reaching the age of 16 or 17, if strong, they received full labourer's wage, usually 1s. 9d. a day. No wages were given boys in the drawing office, while apprentices for special periods had different rates, and the wages charged for men working on repairs at the neighbouring mines varied. The only holidays at these works were Christmas Day and Good Friday, although the latter was not always entirely so.

On the dissolution of the company many of the workmen were dispersed throughout the country, while others emigrated to America and other foreign countries. Many who were older never worked again.

Samuel Hocking and William John Spray are examples of men who enriched other Cornish establishments, while Sir William Mathews, K.C.M.G., is an example of the heights to which Copperhouse men have risen, he having been a President of the Institution of Civil Engineers.

Thus ends the brief story of one of the foremost industrial undertakings in Cornwall of the last century. Although this company went out of business and Cornwall is not so industrialised as many of the places of Wales, the North and the Midlands, the great engineering traditions which centred around this and the other Cornish foundries of the last century are still carried on by the younger firms in the county.

* These figures must of course be more than doubled to compare with to-day's levels.

Ten Years of Progress in Grey Cast Iron*

By Dr. JAMES T. MACKENZIE

The discovery of the effects of superheat by Elliott and Piwowarsky in the previous decade has been assiduously followed up by a number of investigators, with the result that there is now a clear conception of the effects of superheating with quite a satisfactory hypothesis for these effects, *i.e.*, the submicroscopic silicates, etc., but this is not universally accepted, and work still continues. The discovery of germination or inoculation by Meehan in the early 20's has been followed by an enormous amount of research, both technical and practical, and has contributed greatly to general understanding of graphitisation phenomena and control of structures.

The alloys—chromium, copper, molybdenum, nickel, titanium and vanadium—have been studied both singly and in combination, though, of course, not exhaustively, since the combinations, especially considering the basic compositions available, are almost infinite. The general principles governing their application have been fairly well cleared up, though much work remains to be done. The austenitic alloys, Ni-Resist and the high chromium irons, have been developed for corrosion and heat resistance, and the martensitic alloy, Ni-Hard, has proved remarkably successful for wear resistant service.

Heat-Treatment

The principles of heat-treatment have been the subject of much study, and this includes the effect of section size, chill casting, nitriding, etc. Centrifugal casting, both in metal moulds and sand moulds, has been developed to a high state of efficiency for pipe, brake drums, cylinder liners, and other cylindrical hollow bodies. Although it was well on its way in the early 20's, centrifugal casting has really come into its own during these last 10 years.

The unique properties of cast iron due to the presence of graphite have been studied by a number of investigators. Notable has been the study of damping capacity, wear and corrosion resistance, machinability, freedom from galling and seizing, and insensitivity to notches, etc. This has developed into the cast-iron camshaft and other automotive parts not thought of 10 years ago. Even crankshafts are now under test with excellent results.

Correlating Tests

The relation of tensile, compressive, torsion and shear strength to transverse modulus of rupture has been correlated with the elastic and plastic behaviour of the material, which is due to the size, shape and distribution of the graphite. The elaboration of the behaviour of cast iron under combined tensile and bending stresses by Schlick at Iowa State College has resulted in the first rational method for the design of cast-iron pipe.

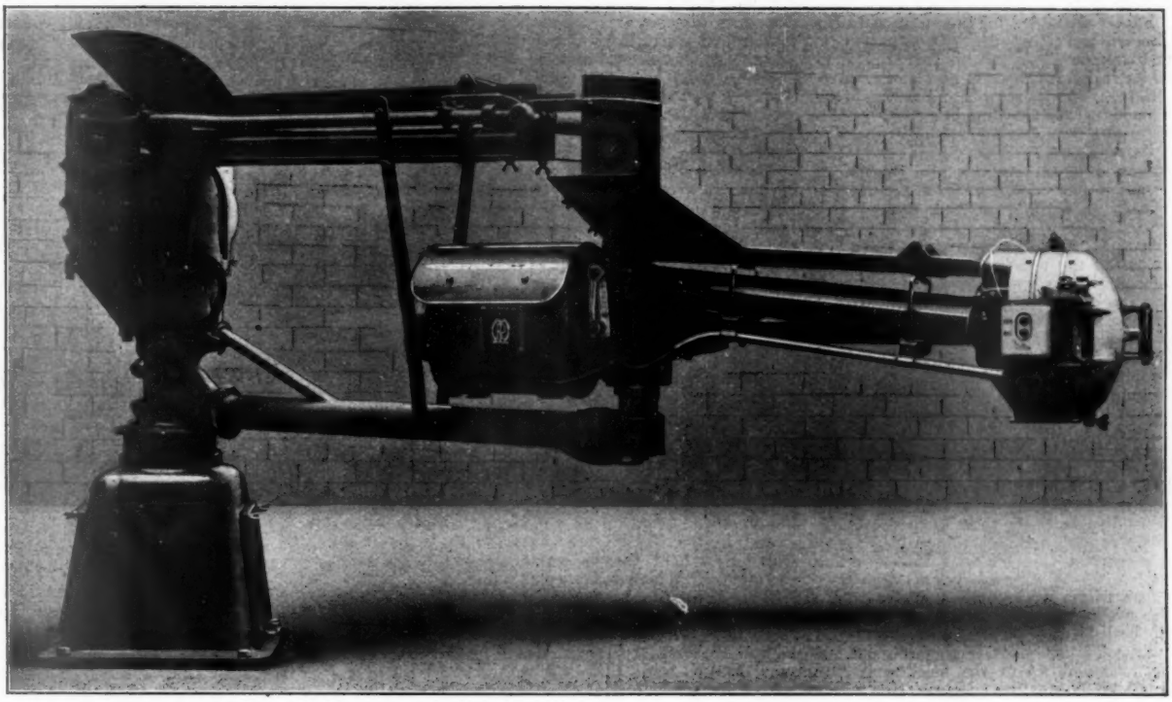
Foundry practice, which is essentially the art of making a sound casting true to pattern, has been studied in detail. Sand control, gating and risering, facings, moulding and coremaking have been studied, and much work has been done to get the principles involved before the designer. The electric furnace has contributed greatly to ease of production and to research. The cupola has been studied intensively and has been equipped with controls for blast volume, temperature, distribution and humidity.

* Extracted from "Metals and Alloys."

SANDSLINGERS

FOR

LARGE SCALE PRODUCTION



The D.B. Model Sandslinger, shown above, is designed for continuous ramming in conjunction with power-driven Turntable on which stripping plate machines are mounted. The moulds, passing in quick succession, are rammed from an unbroken stream of sand from the Slinger head, stripped down, and removed for closing. New boxes are placed in position while the Turntable rotates at a constant pre-arranged speed.

★ Alternatively, the Slinger arm, rotating through 360°, may pass over a succession of fixed moulding points placed round a circle in the path of the ramming head.

Examples of normal production on these systems by ONE machine are :—

★ 900 C.I. Pipes (6 ft. long × 4 in. dia.) per 8-hour shift ;
80 Standard C.I. Baths per 8-hour shift.

Equally impressive results are being regularly obtained on automobile and other classes of castings.

A mass production unit — operated by one man.

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The Week's News in Brief

Trade Talk

MOTHERWELL FOUNDRY COMPANY, LIMITED, are to carry out extensions to their Shields Foundry, to be used for moulding and fettling.

THOS. JENKINS & SON (BRITON FERRY), LIMITED, scrap metal merchants, works dismantlers, etc., have removed to 4/6, Exchange Buildings, Port Talbot.

HEENAN & FROUDE, LIMITED, manufacturing electrical engineers and iron founders, propose to increase their capital to £500,000 by the creation of 1,000,000 5s. shares.

THE ANNUAL MEETING of the Meehanite Research Institute of America was held in Detroit on November 1 to 3. Papers scheduled for presentation to the meeting numbered more than 50.

THE INSTITUTION OF ENGINEERING INSPECTION announces that its registered office is now at 5, Pierrepont Street, Bath, where its records and routine work will be accommodated for the time being.

MEMBERSHIP OF THE Amalgamated Engineering Union has passed the 400,000 mark. The total is now 404,668—an increase on the past month of 8,643. The union has 3,788 members signing the unemployed books—a decrease of 880 compared with a month ago.

THE GENERAL ELECTRIC COMPANY, LIMITED, has decided that during the war the "G.E.C. Journal" will be published twice a year, instead of quarterly. The next issue will appear in February, 1940, and will contain a review of electrical progress and development during 1939.

AN EXTENSIVE working foundry exhibit has been placed in commission in Chicago's Museum of Science and Industry. It was planned in conjunction with the Chicago Chapter of the American Foundrymen's Association, whose second annual regional conference was held in the city last week.

THE DIRECTORS of Bull's Metal & Melloid Company, Limited, state that the offer to purchase the company's shares has already been accepted by the holders of considerably more than 51 per cent. of the issued share capital, and, accordingly, the transaction will be carried through with the accepting shareholders.

IRONFOUNDERS whose works are situated within a 15-mile radius of Luton have been invited to attend a meeting, to be held at 11.30 a.m. on November 21 at the Chamber of Commerce Offices, George Street West, Luton. The object of the meeting is "to consider the wisdom of creating an association within a predetermined area, having for its object the creation of a committee of ironfounders who are capable of voicing such demands as may be necessary for the preservation of fair treatment and just trading facilities within the industry."

ACCORDING to practice in the engineering industry, six months must elapse between any alteration in wages and the reopening of the matter. As the last advance of wages was made in June, the six months will not expire until the middle of December. Recently, in response to a request by the Amalgamated Engineering Union for an opportunity to raise certain questions concerning wages, there was an informal meeting between officials of the Engineering and Allied Employers' National Federation and the executive committee of the union. Only procedure was discussed.

New Companies

Aluminium Bronze Casting Company (Balham), Limited, 332, Balham High Road, London, S.W.17—Capital £1,000. Directors: F. D., C. L., and A. A. Matthews.

James Hodgkinson (Salford), Limited, Ford Lane Works, Pendleton, Salford, Lancs—Capital £65,000. To acquire the business of James Hodgkinson (Salford), Limited, and to carry on the business of engineers, founders, etc. Directors: Col. L. Manton, A. Hodgkinson, E. L. Hollinshead, A. Graystock, and N. C. Crighton.

Lawton (Engineers & Brassfounders), Limited—Capital £1,000. To take over the business of an engineer and brassfounder belonging to H. A. Clowes, trading as "Lawton" at Clayton Street, Longton, Stoke-on-Trent. Directors: F. Peake, jun., "Windy Ridge," Sneyd Avenue, Newcastle, Staffs; E. G. Peake, and C. G. Peake.

Personal

HERR FRITZ THYSSEN, chairman of the Vereinigte Stahlwerke and originally a supporter of the Nazi Party, has fled to Switzerland, according to the Amsterdam "Telegraaf."

MR. AMBROSE CALLIGHAN, who in April last was elected president of the National Union of Blastfurnacemen, has been appointed to succeed the late Mr. Thomas McKenna as general secretary of the union.

MR. AND MRS. ASHLEY S. WARD, of Sheffield, have received a presentation from the staff of Marshall Sons & Company (Successors), Limited, of Gainsborough, of which Mr. Ward is managing director, to mark their appointment as Master and Mistress Cutler.

MR. WILLIAM ROBERTSON and Mr. Thomas Cameron, who have fifty years' service each with the New Grange Foundry of Bo'ness, have been presented with a sum of money on their retirement. The managing director, Mr. James B. Ballantyne, made the presentation at his home.

EMERITUS PROFESSOR F. C. LEA, formerly Dean of the Faculty of Engineering at Sheffield University, has been elected a vice-president of the Institution of Mechanical Engineers. Prof. Lea and Dr. J. G. Whitman were recently awarded the Telford Premium of the Institution of Civil Engineers for their contribution on "The Fracture of Riveted and Welded Structures under Repeated Stresses."

MR. P. J. POTTER, who was elected President of the Foundry Equipment Manufacturers' Association (America) at the annual meeting at White Sulphur Springs, West Virginia, last month, is vice-president of the well-known Pangborn Corporation, Hagerstown, Ind. He has been associated with that company for nearly 25 years. Mr. Potter was born in this country, but has lived in the States since he was 10 years old.

VISCOUNT FALMOUTH, who was president-elect of the Junior Institution of Engineers, recently suggested to the Council that since it would be impossible to hold the inaugural meeting at which the new President delivers his address, it would be best if the President continued in office for the duration of the war. The Council have approached Sir Charles H. Bressey, the present president, and he has consented to continue as President for the year 1939-40.

MR. BERTIE JONES, of the General Electric Company, Limited, has recently retired after over 60 years' business life and nearly 50 years' service with the company, thus having been one of its oldest servants. Mr. Jones's early years with the G.E.C. were spent as a traveller for export business, and during this period he built up a connection with a large number of shippers. From this his activities were directed towards the organisation of G.E.C. stands at exhibitions, and he played a large part in the success of the All-Electric Exhibition at Olympia in 1910. In 1911 his experience as an export traveller stood him in good stead when he was appointed Export Sales Manager, following which he became Sales Superintendent. In this position, he looked after the interests of a number of the biggest customers of the G.E.C.

Wills

MUXLOW, E., chairman of Muxlow & Knott, Limited, steel manufacturers, Sheffield	£3,460
NORTH, WILMOT, of Sheffield, chairman and managing director of the Aurora Gearing Company (Wilmot North), Limited, gear manufacturers and pattern makers	£3,134
WIGGLESWORTH, F., of Menston, founder and managing director of Frank Wigglesworth & Company, Limited, ironfounders, Shipley	£197,878

An article in "Colville's Magazine" recalls that this year marks the 75th anniversary of the first public showing of a photomicrograph of a metallic structure by Dr. H. C. Sorby, F.R.S. The first printed reproduction of a photograph of this type appeared in the Journal of the Iron and Steel Institute in 1887, but only as "pasted-in" slips.

Obituary

MR. THOMAS CAMERON, a native of Glasgow, who, going to America in 1908, settled at Belleville, Ill., where he became President of the foundry employees' union, has died there at the age of 59.

WE REGRET to record the death, on November 2, of Mr. Wilfred R. Hill, who for over 20 years had acted as representative of the Carborundum Company, Limited, Trafford Park, Manchester, on the North-East Coast.

Reports and Dividends

Guest, Keen & Nettlefolds, Limited—Ordinary interim dividend of 2½ per cent., tax free.

Metal Industries, Limited—Interim dividend on the "A" and "B" ordinary stock of 2½ per cent.

International Nickel Company of Canada, Limited—Quarterly dividend of 50 cents per share on the common stock.

Heenan & Froude, Limited—Profit for the year to August 31, £53,965; dividend of 10 per cent. and a bonus of 5 per cent.

Qualcast, Limited—Final ordinary dividend of 10 per cent., plus a cash bonus of 10 per cent., making 30 per cent. for the 12 months to June 30.

Yarrow & Company, Limited—Net profit for the year ended June 30 last, £65,642; brought in, £27,392; to general reserve, £35,000; dividend of 20 per cent., tax free; carried forward, £28,033. Meeting, November 22.

Cupola Melting of Special Irons

(*Concluded from page* 341.)

maximum of 1,480 deg. C. should never be exceeded on remelting the iron, otherwise the natural characteristics or so-called inherent properties of the iron are entirely destroyed and instead of obtaining a tough strong iron one gets a brittle iron liable to chilling in even moderate sections. The main trouble is that although the tensile strength may be higher in the latter iron, the main purposes for which iron castings are made, namely, to resist repeated shocks and strains, are defeated.

One should always remember that the factors of safety adopted by engineers and designers give quite enough latitude to allow of the utilisation of much lower tensile strengths in the iron. With cast iron what one gains in tensile strength is by no means made up in toughness and resistance to deformation. With tough irons of a moderate tensile strength the rigidity obtained is quite sufficient in many cases to preclude the use of even steel castings.

In conclusion it may be said that the methods of annealing castings to obtain greater strengths is only a substitute, and an expensive one, for controlled melting in the cupola. Annealing simply completes what should have taken place during the melting process and prevents internal strains due to interrupted phase-changes in the cooling of the castings.

Forthcoming Events

Institute of British Foundrymen

NOVEMBER 24.
Falkirk Section:—Presentation and discussion of three short Papers.

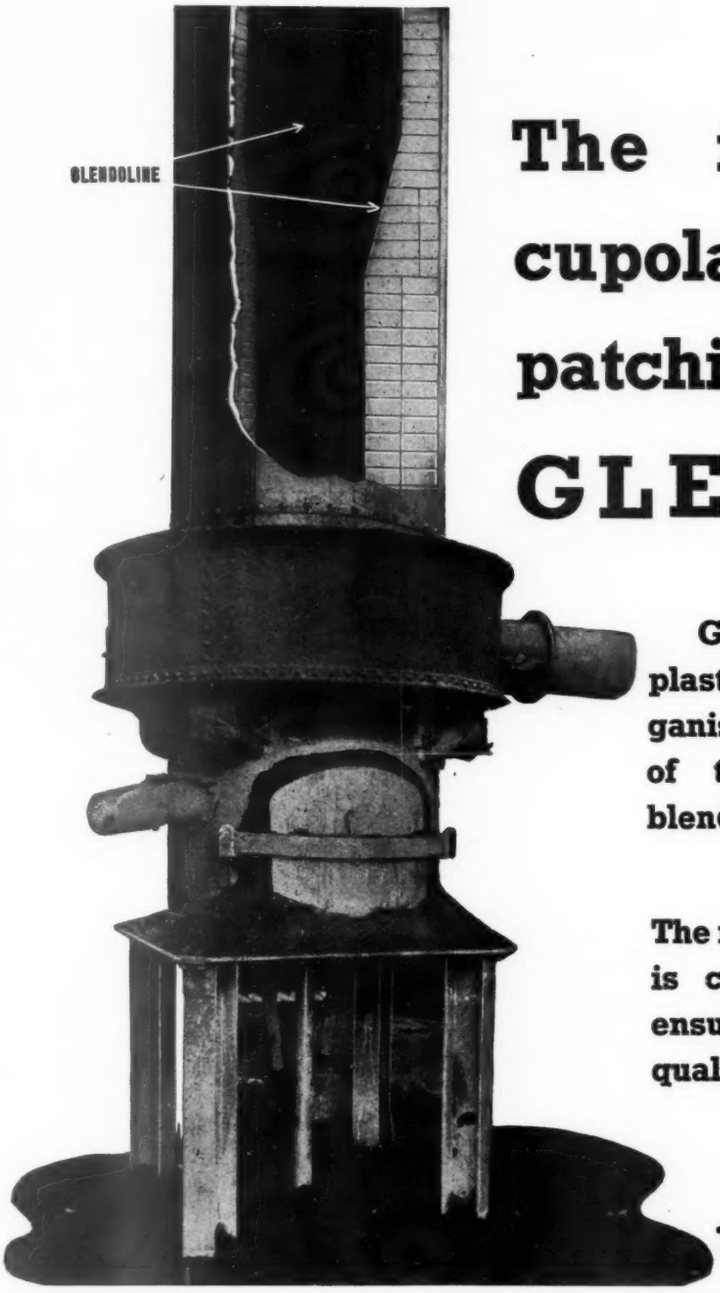
NOVEMBER 25.
London Branch:—"Foundry Layout," Paper by F. J. Cook, M.I.Mech.E., at Charing Cross Hotel, London, W.C.2, at 2 p.m.

Institute of Vitreous Enamellers

NOVEMBER 20.
Scottish Section:—Future activities of the Institute. Discussion of Joint Technical Report, "Recommended Method of Testing Acid Resistance of Enamels," at Royal Technical College, Glasgow, at 6.30 p.m.

NOVEMBER 22.
Southern Section:—Future activities of the Institute. Discussion of Joint Technical Report, "Recommended Method of Testing Acid Resistance of Enamels." "Effect of Climatic Conditions on Vitreous Enamel," Paper by Dr. B. Deutsch, at Charing Cross Hotel, London, W.C.2, at 7 p.m.

NOVEMBER 23.
Midland Section:—Future activities of the Institute. Discussion of Joint Technical Report, "Recommended Method of Testing Acid Resistance of Enamels." "Recent Developments in De-enamelling," Paper by R. L. Evans, at Chamber of Commerce, New Street, Birmingham, at 7 p.m.



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The mixing and grading of Glendoline is controlled to a definite formula, ensuring dependable and uniform quality.

★ EXTREMELY PLASTIC
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★ GREAT MECHANICAL STRENGTH

★ This photograph of a cupola, shows a portion of the lining and the positions where Glendoline is recommended for lining and patching.

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Raw Material Markets

The higher prices introduced for iron and steel at the beginning of this month have made little, if any, difference to market conditions generally, and business continues to be very heavy. On the whole, consumers were gratified at the extent of the price increases, as many had expected steeper advances. There continues to be a heavy demand for both iron and steel outside the requirements of national defence, and while there is still a considerable amount of delay, deliveries are improving and should do so still further as industry becomes acclimatised to war conditions.

Pig-Iron

MIDDLESBROUGH—The foundry-iron trade is now fully controlled, as it is necessary for all consumers to obtain licences before deliveries of iron can be assigned to them. This move will ensure that iron wanted for urgent work will be available without delay, and that users hoping to build up stocks as a reserve will be unable to do so if there are other orders to be met. Thus, for a considerable time, at least, licences will only be issued for iron for immediate consumption. Most foundry-iron users in this area have been drawing their requirements from the Midlands for a considerable time past, and this policy is likely to continue, as Cleveland-iron makers have not been producing foundry iron of late. The rebate of 5s. per ton for buyers using home-produced iron only continues to be in force, but there is little inducement to users to buy abroad, despite the abolition of the import duty. The hematite trade remains very active, and producers are themselves consuming heavy tonnages in their own plants. There has also been a more insistent demand from other consumers, and stocks have thus been reduced quite considerably during the past few weeks. Distribution is now controlled officially; in view of the many difficulties involved nowadays this system has been welcomed by makers, many of whom did not find it easy to discriminate among buyers owing to the pressing requirements of seemingly all users.

LANCASHIRE—The improvement among consumers of pig-iron in this area since the outbreak of hostilities has been fairly general, but there are still certain sections which could do with additional orders on their books. Light-castings and jobbing foundries, while mostly better placed than they were, continue to operate below full-capacity levels. Textile-machinery makers, too, are generally open to new business. On the other hand, heavy electrical and machine-tool concerns are hard pressed to deal with work already on their books and the consumption of iron among these users is ever expanding. Some difficulties are prevalent owing to the shortage of scrap and higher prices would willingly be paid were the material available. Derbyshire and Staffordshire brands of No. 3 foundry iron are now quoted at 113s., with Northamptonshire No. 3 at 111s. 6d. and Derbyshire forge iron at from 110s. to 112s., according to the class of consumer.

MIDLANDS—All new business is now transacted on the understanding that consumers state their position as regards stocks and potential requirements when applying for additional tonnages. Thus, unless buyers have real need for further supplies for immediate consumption licences will not be issued. Although this form of rationing supplies has been evolved, supplies of high-phosphorus iron are fairly freely available and the position is expected to improve. Hematite and low-phosphorus irons continue to be in heavy demand; with regard to the increase in the price of the latter, it is felt that the new price is very high as compared with the uncontrolled figure ruling prior to the war. An additional 9s. per ton on high-phosphorus iron and hematite caused little surprise to buyers. The new price level for finished castings has by no means met with universal approval and ironfounders have objected to the revision as it stands at present.

SCOTLAND—In view of the present policy of dealing only with consumers' immediate requirements, current business is on a day-to-day basis. It is difficult for consumers to build up a reserve stock, as they must first prove the need before acquiring the licence necessary for them to obtain additional supplies. No. 3 foundry iron is now quoted at 109s. 6d. per ton, f.o.t. furnaces. Fourteen blast furnaces continue to operate in this area, but additional output would easily be taken up. Light-castings foundries are better placed than they were a few weeks ago, but order-books cannot yet be described as satisfactory. Steelworks continue to call for substantial tonnages of iron and deliveries are despatched as freely as possible.

Coke

Foundry-coke prices are, of course, fixed by the Control authorities, but so far no change has been made in the price of 50s. 6d. per ton, delivered Birmingham and Black Country stations. Not a lot of business is now being done, as most users have already covered their requirements over a considerable time to come.

Steel

Steelmakers continue to be pressed for supplies and there is no relaxation in any section of the market. Government orders appear to be rather more plentiful and these, of course, are first to receive consideration, although ordinary civil orders are dealt with when possible. There can be little doubt that since the outbreak of war defence projects have gone ahead at a brisk pace and thus the First Lord of the Admiralty was able to broadcast on Sunday the statement that Great Britain was much stronger now than ten weeks ago. Steelworks are finding some difficulty in obtaining adequate supplies of scrap, but with the intensification of the scrap collection campaign this position should be relieved.

Scrap

It is suggested in some quarters that the supply position of iron and steel scrap would have been relieved quite materially had prices been fixed at higher levels, but considered opinion is that this would not have been the case. Home production at the moment is insufficient adequately to meet the demand and unless imports are speeded up little relief will be obtained. Much is expected from the campaign now being carried out by the British Iron and Steel Federation, but the real solution to the problem lies in the receipt of more scrap from abroad. No doubt this will result later and it is fortunate that with the U-boat menace under control and steadily declining difficulties in transport are unlikely to restrict the tonnages arriving at ports of this country. Imported material will, of course, increase the costs of production, but this can hardly be avoided. New schedules of scrap prices are expected shortly. About 45,000 tons of scrap iron and steel have already been passed on to steelworks in the United Kingdom within three weeks of the introduction of the collection campaign.

Metals

Copper—The demand for this metal by firms engaged on Government contracts continues to be heavy, but there appears to be little delay in meeting orders, and other consumers, too, are getting their requirements satisfied. Official confirmation of a report that Rhodesian copper producers have entered into a contract with the Ministry of Supply for the sale of a large proportion of their output for the duration of the war has been given during the past week. The price to be paid is a fixed price and approximates to the level ruling immediately before the war. The proportion of Rhodesian output to be taken by the British Government is understood to be 80 per cent.

M. Sengier, managing director of the Belgian mining concern, Union Minière du Haut-Katanga, is understood to have made arrangements for the sale of the entire copper output of the concern during a visit which he has made to New York. Part of the production is to be refined in the United States and about 5,000 tons a month in the Belgian Congo. The company is adopting the "cash and carry" system for its foreign sales.

Reports from America indicate that the United States copper production may attain a level of 90,000 short tons a month by the end of the year. As most buyers there have satisfied their needs well into next year, business at present is not heavy. It was originally understood that the price of copper involved in the recent agreement between the British Government and Canadian producing interests was 10¼ cents per lb., but later reports indicate a price of £48 10s., f.o.b.

Tin—While the amount of business done in this metal is still restricted by the shortage of supplies, the daily turnovers on the London Metal Exchange have been slightly heavier of late. In fact, on Friday last, for the first time for several weeks, sales were not confined to the 25 tons daily allocated to the market by the buffer pool.

The aggravation of the political situation between Holland and Germany has aroused considerable conjecture in respect of the commercial interests of the two countries. It is well known that in order to carry on a long war Germany will need very heavy tonnages of tin and rubber, both of which she normally imports from Dutch interests. Thus by entering Holland, Germany would to a large extent be still further jeopardising her chances of being successful in a prolonged war, as she would find it extremely difficult to procure supplies from the Dutch Empire. In 1938 the Reich imported 3,935 tons of tin from Holland and 3,980 tons from the Netherlands East Indies, making 7,915 tons out of a total tonnage of imported tin of 11,899 tons. Thus, Germany is now faced with searching for a new source of supply, but as Mr. Winston Churchill said in his broadcast on Sunday last, "Germany has not a friend in the world," and while she may turn to the Soviet Union in order to replenish her tin stocks, she is certain to draw a blank there, as Russia is frequently in the markets of the world for supplies for her own use. Under a barter agreement negotiated between Russia and Great Britain some weeks ago the U.S.S.R. is taking tin from this country, but only on the understanding that none of the metal is re-exported to Germany. Deliveries of tin from Holland have fallen away very considerably during the first ten weeks of the war, although tin stocks in Holland are considerable, and Dutch interests are hopeful of selling large quantities to the United States.

Speaking at the annual meeting of Ayer Hitam Tin Dredging, Limited, Mr. C. V. Thomas (chairman) said that in Malaya restriction had not resulted in the orderly extraction of the metal. He considered that Malaya should revert to unrestricted production forthwith for a minimum period of at least 12 months, and that if such action were taken it would remove the disparity in prices ruling in the United Kingdom and United States, as a result of which it was decided to introduce price control.

Tinplate mills in the United States are currently operating at around 95 per cent. of capacity, estimated to yield 3,250,000 tons per annum, which constitutes a record.

Spelter—Working-up industries continue to operate at a high rate of activity; the supply of metal to meet the increased requirements of industry on a war basis is satisfactory, but there appears to be little surplus.

Lead—On the whole, consumers' needs are being met without undue delay, but there is certainly little spare metal about. The building industry, of course, has been severely hit by the war, but industries connected with defence projects are fully active, and consumption of lead must be approaching record levels.

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